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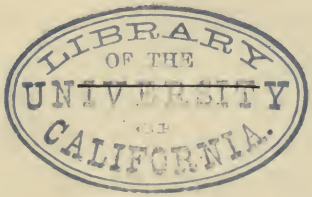
MILITARY LESSONS:

MILITARY SCHOOLS, COLLEGES, AND MILITIA.

By PROF. W. T. WELCKER,

PROFESSOR OF MATHEMATICS AND CHIEF OF MILITARY INSTRUCTION IN THE UNIVERSITY OF CALIFORNIA.



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PREFACE.

IN presenting this little volume to the public, the author has sought to meet what he believes to be a want of the numerous private military schools of the United States, of those institutions of higher learning where a limited amount of military instruction is given, and of the militia of the different States. The late wars, home and foreign, have shown that a mere knowledge of tactics is no longer sufficient; that some further knowledge of the art of war is requisite, not only among those destined to be officers, but even among the private soldiers. And it is believed that the works heretofore published upon some of the topics treated have been too elaborate, scientific, and technical for those who will be prevented, either by want of technical preparation or by want of time, from pursuing the studies in an exhaustive manner.

There is but little claim to originality advanced; the following chapters are, in the main, either trans-

lations or compilations from various standard authorities on the different subjects treated.

But, while the author deems the information given sound and valuable, he has avoided, as far as possible, introducing mathematics or other scientific matter suitable only for the professional officer, who studies the whole subject thoroughly, or who perhaps is devoted to a single branch, such as military engineering or artillery. The aim has been to suit the work to all who have received a common-school education.

It has grown up as the result of military instruction, over and above that in drill and tactics, given to the students of the University of California.

W. T. WELCKER.

University of California,
August, 1874.

CONTENTS.

CHAPTER I.

COMPOSITION AND ORGANIZATION OF ARMIES.

	PAGE
Divisions of Troops, — Infantry, Cavalry, Artillery	1
Greek Phalanx	6
Roman Legion	7
Feudal Period	11
Heavy Infantry	14
Grenadiers	15
Different Kinds of Cavalry, Cuirassiers, etc.	15
Light Cavalry	18
Dragoons	18
Hussars	19
Lancers	20
Artillery	21
Engineer Troops	23

CHAPTER II.

SUPPLY OF ARMIES.

Pay	24
Pay in European Services	26
Subsistence Department	28
Supply of Clothing and Equipage	31
Medical Supplies	33

CHAPTER III.

MOVING OF ARMIES.

Different Methods of transporting Armies	35
In the Neighborhood of the Enemy	37
Rear-Guard on a Retreat	39
Flank-Guards	40

Trains 41
Of Halts 42
Commander-in-Chief 43
Commander of the Advanced-Guard 45
Selection of Camps 47
Commander of the Rear-Guard in Retreat 48
Duties of the Commanders of Flank, Advanced, and Rear Detachments 49
Duties of Patrols during a March 51
Regulating Marches by the Nature of the Ground 54

CHAPTER IV.

PASSAGE OF RIVERS ON ICE, BY FORDS, BY BOATS, AND ON RAFTS.

Selection of the Point of Crossing 58
To determine the Velocity of the Current 63
Passage by Swimming 66
Passage on Ice 67
Fords 67
Passage by Boats 71
Navigation 75
Rafts and Foot-Bridges 77

CHAPTER V.

MILITARY BRIDGES IN GENERAL.

Bridge over Hellespont by Xerxes 80
Bridges of Boats 83
Pontons of Equipage 85
Bridges on Country Boats 86
Bridges on Rafts of Logs 87
To find the Power of Flotation 88
Bridges on Rafts of Casks, Boxes, and Skins 89
Trestle-Bridges 90
Preservation of Bridges 92
Passage of Bridges 93
Flying-Bridges 95
Destruction of Bridges 96
Destruction of the Enemy's Bridges 97

CHAPTER VI.

FIELD FORTIFICATION.

Art of Fortification 99
Profile of Parapet and Ditch 102
Plan 102

Redoubt 104
Flanked Dispositions 104
Star Forts 106
Cremaillère, Redan, Lunette, Priest-Cap 107
Tête-de-pont 108
Revetments 108
Fascines 108
Hurdle Revetments 109
Gabions 109
Powder Magazines 109
Traverses 110
Palisades 110
Block-Houses 111
Obstacles 111
Chevaux-de-frise, Crow's-Feet, Abattis 112
Attack and Defense 112
Defense 114

CHAPTER VII.

STRATEGY.

Strategy defined 116
Line of Operations 118
Defensive Plan 123

CHAPTER VIII.

THEORY OF FIRE AND TARGET PRACTICE.

Initial Velocity 127
Recoil 129
Heating of the Barrel 130
To find the Hausse 134
Construction of the Trajectory 135
Causes of Deviation in the Projectile 135
Combined Effect of the Action of the Air, and of Imperfections in the Projectile 136
Deviation from Unskillfulness of the Marksman 138
Stadia 139
To calculate the Initial Velocity 140

CHAPTER IX.

SMALL-ARMS.

Crossbow 149
Arquebuse 150
Firearms 151

Different Methods of forcing the Ball into the Grooves . . . 161
Pontchara System 163
Système à tige 163
Balle à culot 167
Minne-Ball 167
Lancaster Rifle 168
Breech-Loaders 169
Repeating Rifles, Remington, Sharpe, Peabody, Ballard, Needle-Gun, Chassepot 170
Winchester Rifle 171

CHAPTER X.

MITRAILLEUSE AND UNITED STATES ORDNANCE.

Ordinance of the United States Service 174
Shell Guns 175
Mortars 175

MILITARY LESSONS.

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CHAPTER I.

COMPOSITION AND ORGANIZATION OF ARMIES.

AN army is a collection of men armed for war, and organized in companies, regiments, brigades, and divisions, under proper officers.

In modern times it is composed of **Infantry,** or foot-soldiers; **Cavalry,** or various kinds of mounted troops; **Artillery,** or those who make use of cannon; and **Engineer Troops,** consisting of sappers and miners, pontoniers and pioneers.

These main divisions have numerous subdivisions, of which the smallest is the **Company.** This is a body of troops varying in numbers from 50 to 200 men; the most usual number being about 100. It is evidently the same thing as the Roman *century,* which was commanded by a *centurion.* Among the Israelites, we read in the Old Testament of "captains of a hundred" as well as of "captains of fifties."

The permanent commander of a company is denominated **Captain.** Besides the captain there are either two or three other officers in every company, called **Lieutenants.** The

captain and the lieutenants are called collectively *company commissioned officers,* because they bear the commission of the king, or other chief of state, with his sign-manual. Lieutenants are classified as **First Lieutenants** and **Second Lieutenants.** The second lieutenant is usually the lowest commissioned officer in an army.

The commission is a letter-patent from the king, or chief executive of the state, declaring that he reposes special trust and confidence in the wisdom, loyalty, patriotism, and valor of A. B., and does thereby appoint him to be (such and such an officer), and requires all officers and soldiers to obey and respect him accordingly.

In the United States service there is also the **Brevet Second Lieutenant,** who is a supernumerary second lieutenant awaiting promotion to the full grade of second lieutenant. Between the *commissioned officers* and the *non-commissioned officers* there intervenes the grade of *warrant officers.* At present there is, in the United States military service, but one kind of warrant officers, i. e. the **Cadet.** The cadet is a young officer bearing a warrant from the Secretary of War, and is not usually assigned to any of the military organizations, but undergoes instruction in the science and art of war at the national Military Academy at West Point. Upon being graduated at this institution and receiving his diploma, he is promoted to some corps of the army as Brevet Second Lieutenant, Second Lieutenant, or sometimes to a higher grade. **Cornets** are warrant officers of cavalry in the English service, and **Ensigns** are warrant officers of infantry.

In company organizations the officers next below are **Sergeants.** This word is derived by some from the Latin word "serviens," and by others from the Persian word "sarchank" or "sarjank," a prefect or subordinate military officer. The latter derivation would seem to be the most probable, from the fact that the word is pronounced *sarjeant,* as if the first syllable were spelled with an *a.*

This officer bears an *appointment* from the colonel of the regiment; he wears a sword, and usually in addition he carries the arm which is borne by the soldiers of his company. The chief sergeant is called the **Orderly Sergeant.** He has, under the commissioned officers, a general control and superintendence over the company, calls the rolls, keeps the roster, and makes the details of the men for guard duty, fatigue duty, and other detachments. He wears a sash like the commissioned officers.

Besides the orderly sergeant there are three, and sometimes four, other sergeants, who have the general superintendence of the soldiers, living in quarters with them to preserve order and discipline, and upon parade are stationed in the "line of file-closers," two paces behind the ranks, to see that the men obey commands and properly perform the movements which may be ordered.

Next to the sergeants are other non-commissioned officers called **Corporals,** who are stationed on the flanks of the companies to guide the same with steadiness; and when any sergeant is absent, that one of them may act in that capacity. On guard each relief is commanded by a corporal. This completes the list of the *officers* of a com-

pany. To every company of infantry there is one drummer and one fifer, and to companies of horse there should be two or more buglers or trumpeters. These compose the *field-music*. The remaining men, who compose the ranks of the company, are called the *privates*.

Eight companies may, but generally ten companies do, compose a **Regiment**; which, if the companies contain one hundred men, would make the regiment eight hundred or one thousand strong. The commander of a regiment is denominated **Colonel**. Next in rank to the colonel is the **Lieutenant-Colonel**; and a **Major** is an officer intermediate between a lieutenant-colonel and a captain. To each regiment there is one, and sometimes two, majors. The colonel, lieutenant-colonel, and major or majors constitute what are called the *field officers*, in contradistinction from the captains and lieutenants, who are known as *company officers*. Any number of companies greater than one and less than a regiment is known as a **Battalion**, and is properly commanded by a lieutenant-colonel or a major.

A **Brigade** is composed generally of two regiments, but sometimes of three or four regiments. This body is commanded by a **Brigadier-General**, the lowest in rank of the *general officers*.

From two to six brigades constitute a **Division**, which is commanded by a **Major-General**. To a division there is generally attached a certain proportion of artillery and cavalry.

A **Corps d'Armée** or **Army Corps** is a body composed of all arms and numbers, from twenty thousand men

to fifty thousand. It is the appropriate command of a **Lieutenant-General,** and is, in effect, an army, and may be detached to act independently. Two or more army corps constitute an army, the commander of which is a **General,** making the fourth and highest rank of *general officers.*

Whenever the proper commander of any of the above-described bodies of organization is absent, the next in rank takes command; i. e. the senior officer present assumes the command. In this way a lieutenant may command a company, a lieutenant-colonel a regiment, a colonel a brigade, a brigadier-general a division, etc. Something like the above sketch, with here and there a variation, will be a description of the organization of every civilized military service.

The necessities of war must always introduce some sort of organization at a very early period, even among the most barbarous nations. The desultory efforts of individuals are speedily found inadequate to meet the shock of men combined in a mass; more especially is this true in champaign countries. There must be a leader, and subordination to a common head, with unity of design everywhere; but a greater looseness and more of individual action is allowable in a broken, mountainous, and timbered region than upon plains. The ease with which a loose and scattered multitude can be swept away upon an open plain by a smaller body of compact infantry, or cut down by cavalry, speedily demonstrates the necessity of organization.

The American Indians display less desire and aptitude for civilization than any people whatever; yet even some

of their tribes have been compelled to adopt something like organization. This is more particularly true of the Comanches, who operate on the extended plains of Texas and the neighboring country.

Greek Phalanx. — The earliest formations of which we have any very intelligible account are the celebrated *Greek phalanx* and *Roman legion*, each of which in its turn conquered the known world. The *grand phalanx* of the Greeks was composed of four phalanxes, each phalanx being composed of 4,096 men. Sixteen men made a file, counting from front to rear; and four files, making sixty-four men, composed a **Tetrarchy**, and was commanded by an officer named a **Tetrarch**, who may be supposed to correspond to the modern captain of infantry. There were thus sixty-four tetrarchies in a phalanx, and the front line contained 256 men. Thus, the phalanx was a solid rectangle of men 256×16. These numbers varied at different epochs.

Four tetrarchies made a **Syntagmatarchy**, commanded by a **Syntagmatarch**, who might correspond with a major of our day, but in the functions of his office more resembled a colonel. The phalanx was commanded by an officer called **Strategos**, who corresponded with our brigadier-general.

The **Heavy Infantry**, or *infantry of the line*, were drawn up sixteen deep, and they bore the long Macedonian pike, which was twenty-four feet long. When this formidable weapon was brought down to the charge, those of the front rank extended twenty-four feet towards the

enemy, and those of the succeeding ranks a less and less distance, unto the sixth rank, whose pikes projected three feet to the front, making a formidable and impenetrable array. The men wore also heavy shields, which they used, in a charge, to cover their persons from missiles coming either from the front or from above. Besides the heavy infantry there were **Light Infantry,** and two kinds of cavalry, *heavy* and *light.*

Upon a plain where it could act well the phalanx was a terrible body for either offence or defence, but it was extremely ill-suited to broken ground or hilly countries. There must also have been a great waste of material, because after the sixth or seventh rank the remainder of the men were idle and nearly useless, except to relieve the others.

Roman Legion. — In the days of the Republic, when it was in reality a republic, and previously to the civil wars which terminated in the establishment of the Cæsars, a Roman army usually consisted of two legions and two wings of auxiliary troops. The legion consisted of heavy infantry, light infantry, and cavalry. The first were covered with defensive armor and wore the short Roman sword, which was two-edged, straight, and heavy. They also carried a javelin about seven feet long, which was named the *pilum.* The light infantry carried a spear called the *hasta,* shorter than the pilum, the short-sword, and had, for defence, only a helmet and leather buckler.

The cavalry, in addition to the helmet and buckler, wore a cuirass for protection; and, for offense, the Greek lance, a long curved sword or saber, and a quiver with darts.

Like the phalanx, the legion at different times contained different numbers of men, but about four thousand was the average. The principal officers were sixty **Centurions**, or captains, and six **Tribunes**, or colonels. In the earlier times these tribunes took the command by turns, each tour of duty lasting two months. Subsequently a permanent commander, styled a **Légātus**, was appointed.

The habitual order of battle of the legion was in three lines within supporting distance of one another, and with cavalry on the wings. The greatest depth of formation was ten ranks, and a portion of the troops were only six deep. Thus, the legion was not so cumbersome as the phalanx, and could adapt itself much more readily to the accidents of the ground.

Just preceding the onset the legionaries hurled their javelins upon the enemy, and then threw themselves upon him with the terrible short-sword. But it is apparent that the legion was not so good, from its composition, to withstand the attacks of cavalry as the formidable array of pikes bristling from the phalanx. Owing to the depth of their ranks, neither would do when exposed to modern firearms and artillery. Imagine the havoc that would be made in a Grecian phalanx by a mitrailleuse!

Before quitting the legion it may be well to adduce the testimony of Josephus upon the subject, although what he says has more reference to the discipline of the legion, its camps and marches, than to its organization. In speaking of the legion as it was in the time of the Emperor Vespasian, he says: —

"If any does but attend to the other parts of their military discipline, he will be forced to confess that their obtaining so large a dominion hath been the acquisition of their valor and not the bare gift of fortune, for they do not begin to use their weapons first in time of war, nor do they then put their hands first into motion, which they avoided so to do in times of peace, but as if their weapons did always cling to them, they have never any truce from warlike exercises, nor do they stay till times of war admonish them to use them; for their military exercises differ not at all from the real use of their arms, but every soldier is every day exercised, and that with great diligence, as if it were in time of war, which is the reason why they bear the fatigues of battles so easily, for neither can any disorder remove them from their usual regularity, nor can fear affright them out of it, nor can labor tire them; which firmness of conduct makes them always to overcome them that have not the same firmness, nor would he be mistaken that should call those their exercises unbloody battles, and their battles bloody exercises.

"Nor can their enemies surprise them with the suddenness of their incursions; for as soon as they have marched into an enemy's land they do not begin to fight till they have walled their camp about, nor is the fence they raise rashly made nor uneven, ... but if it happens that the ground is uneven it is first leveled; their camp is also four square by measure, and carpenters are ready in great numbers with their tools to erect the buildings for them.

"As for what is within the camp, it is set apart for

tents, but the outward circumference of it hath the resemblance to a wall, and is adorned with towers at equal distances, where between the towers stand the engines for throwing arrows and darts and for slinging stones, and where they lay all other engines that can annoy the enemy all ready for their several operations. They also erect four gates, one at every side of the circumference, and those large enough for the entrance of the beasts and wide enough for the making of excursions if occasion should require. . . . .

"When they have secured themselves, they live together by companies in quietness and decency, as are all their affairs managed with good order and security. Each company hath also their wood and their corn and their water brought to them when they stand in need of them, for they neither sup nor dine as they please themselves, singly, but all together. Their times also for sleeping and watching and rising are notified beforehand by the sound of trumpets. . . . .

"Now when they are to go out of their camp the trumpet gives a sound, at which time nobody lies still, but at the first intimation they take down their tents and all is made ready for their going out; then do the trumpets sound again to order them to get ready for the march, then do they lay their baggage suddenly upon their mules and other beasts of burden, and stand as at the place of starting ready to march. Then does the crier stand at the general's right hand and ask them thrice in their own tongue whether they be now ready to go out to war or not. To which they reply as often with a loud and cheerful voice, 'We are

ready!' And this they do almost before the question is asked them; they do this as filled with a kind of martial fury, and at the same time that they so cry out they lift up their right hands also.

"When after this they are gone out of their camp they all march without noise, and in a decent manner, and every one keeps his own rank, as they were going to war."

The extracts from Josephus here made are somewhat copious, but it is thought that the reproduction of the daily camp life and discipline of those renowned veterans who subdued the world, as it took place eighteen centuries ago, cannot fail to be interesting and instructive to the military student.

Subsequent to the decay of the Roman discipline and the loss of the legionary organization, after a long interval we come to the **Feudal Period.** During this period the bulk of armies was cavalry, and with but little of organization. Tactics and strategy were almost unknown. Everything was remitted to individual courage, skill, and enterprise. Two armies were two great mobs who sought each other, and when confronted, after some interchanges, through their respective heralds-at-arms, of courtesies or defiances, fell upon each other pell-mell in two long paralled lines, and fought with ferocity and much exhibition of physical strength and manual dexterity. The accounts of the battles in which the destinies of nations were decided are the accounts of a series of detached combats along the lines, where the greatest kings and leaders were doing and could only do the duties of private soldiers; and he who could

swing the heaviest battle-ax with the greatest skill was the greatest general. It is not asserted that there were no exceptions to this statement, but it may fairly represent the system. The cavaliers as well as their horses were generally clothed in heavy defensive armor.

As we advance towards modern times we behold the second rise of military science.

The Swiss infantry first demonstrated the superior virtue of organization, and of disciplined concert of action. These troops, really deserving that name, were not only able to defend their own country, but soon were found as mercenaries in most of the continental states of Europe; their palpable superiority causing them to be regarded as indispensable auxiliaries.

A succession of able leaders appeared from time to time; such as William and Maurice of Orange and Nassau, Gustavus Adolphus, Turenne, Condé, Eugene, and Marlborough, who restored the lost principles and spirit of the art and science of war, and adapted them to firearms and cannon. The bayonet replaced the pike, and the deep formations of infantry were abandoned, to avoid the excessive slaughter by projectiles launched by the enormous force of gunpowder, and also to utilize one's own muskets by a more extended line of battle for the same number of troops. Infantry was ranged in three ranks and two or three lines at a good supporting distance from each other, with artillery in the intervals of battalions, and cavalry on the wings or in rear, to be hurled at the opportune moment against the enemy's forces, when shaken by the fire

of infantry or artillery. The three arms were united, and caused to co-operate in suitable proportions to each other. The improvements of this kind were carried still further by Frederick the Great and Napoleon. The infantry was discovered to be the mainstay, the grand frame of the army, and the only arm which was self-sustaining and capable of acting alone.

The part of **Artillery** is to produce a great moral effect upon the enemy, to demoralize him by its terrible roar and the tremendous crash of its great projectiles, which demolish houses and tear their way to the extreme rear of columns; to strike him at long range, and to prevent his coming out from cover at particular points; to shake his masses of infantry or cavalry previous to a charge; and to concentrate upon his columns advancing to the attack a heavy cannonade while yet a great way off, and to shatter them with grape-shot (or small and numerous projectiles) when within short range.

The **Cavalry** were found to be invaluable in escorts, reconnoissances, and outpost service; to fight the enemy's cavalry, and to charge his infantry when broken by the charge or fire of infantry, or by artillery fire; to complete the rout and dispersion, and to make prisoners.

Generals learned to use the different arms either simultaneously or successively, according to the demands of the hour or locality; sending infantry to strike or dislodge the enemy, over ground impassable by artillery and cavalry; and artillery to annoy or drive the enemy when posted beyond streams out of range of muskets and impassable by

cavalry; to make use of the speed of cavalry in surprises; by concealed marches to burst upon the enemy's flank or rear, or to cut his communications and capture his supplies.

As before remarked, the infantry is the principal arm of the organization; hence the bulk of the troops must be of that description.

The cavalry should, according to the nature of the theater of war, vary from one sixth to one fourth of the number of the infantry. The smaller proportion is used in broken and mountainous districts, and the larger in level countries.

Proportion of Artillery. — About *two pieces of artillery* — field artillery — *to every thousand* of the sum of the infantry and cavalry have been generally deemed correct. Napoleon increased this proportion somewhat, and the tendency of ideas still more recent seems to be in the same direction.

Heavy Infantry. — Infantry has generally been subdivided into heavy infantry, or *infantry of the line*, and *light infantry*. In early times the former were generally armed with a sword; but while it has always been debatable whether it was not injudicious to load the soldier down with this encumbrance, and to fail to rely upon the bayonet, it can scarcely be doubted that the arrangement is bad nowadays, when the bayonet exercise is universally taught.

In the United States service no distinction is made among the infantry. Arms of precision and long range are issued to all, and all are expected to learn the skill in the use of the weapon, and the agility of body and celerity of

action necessary to the movements of skirmishers and of light infantry.

Occasionally we hear the term **Grenadiers.** This name is a relic of the former custom of selecting certain of the largest and strongest men, who were trained to hurl by hand lighted grenades or shells into the ranks of the enemy. The practice still prevails among the besieged, who throw these hand-grenades over the ramparts upon the enemy when he has got into the ditch and is endeavoring to mount the breach.

Different Kinds of Cavalry. — There are some subdivisions of mounted troops which are worthy of a passing notice.

Cuirassiers, or *heavy cavalry.* These troops are so denominated from the *cuirass* — a defensive armor for the body — which they wear. The cuirass is a kind of close-fitting metallic jacket, and is composed of a *plastron* or breastplate, a *back,* and a *padding* on the inside. This internal upholstering is to prevent the cuirass galling or abrading the skin of the wearer, and to make it set well upon him. The back and plastron are united at top by leather straps or suspenders, which are covered over with brass in order that they shall not be cut in two by a blow from the saber. A leather belt and buckle unite the pieces below at the waist. The front of the cuirass is formed into a protuberant angle, in order to give greater obliquity to the sides of this defensive armor, and to cause balls which strike it to glance off.

Both the plastron and back are bordered by a raised rim

or groove, to arrest the point of the saber on occasion of a thrust, and prevent its passing off on to parts of the body which are not protected. Cuirasses are made of iron and steel; the breastplate, but not the back, being tempered. The plastron is ball-proof at the distance of forty-five yards; the back is only saber-proof. This distance is fixed upon, because when cavalry in a charge upon infantry have arrived within forty-five yards, the infantry have no more time to fire, but must promptly betake themselves to the bayonet; hence it is not necessary that the cuirass should be ball-proof within that distance. But now that we have repeating rifles which can be fired up to the last moment, this consideration is no longer sound. The backs are made saber-proof, and not ball-proof, in order that the horseman may feel that it is safer to *face* the enemy than to *turn back* upon him.

After the introduction of firearms, defensive armor had been completely abandoned; but the cuirass and helmet were restored by Napoleon, who clearly perceived the advantages of their use to heavy cavalry. Sappers and miners should be protected by defensive armor while opening trenches and pushing approaches. For them the back of the cuirass should be bullet-proof, for they are compelled to expose their backs while in the attitude of digging.

The cavalry helmet is made of the same materials and on the same principles as the cuirass.

The cuirassiers are armed with a saber and pistol. In some armies a certain proportion of them are armed with a musketoon or carbine also; but the firearm should be a

matter of but little importance, for it is by their *shock* that heavy cavalry should expect success; therefore their main reliance ought to be upon the *spur* and the *saber*. They should be held in reserve under cover till the opportune moment for charging, and then launched against the masses of the enemy, shaken and wavering from the fire of artillery or infantry, or from any other cause. If a general can succeed in hurling his cuirassiers against the flank of an enemy's column, his success may be considered as assured.

There is but little use in cavalry charges against well-formed squares of veteran infantry, or even when in line. The fire of musketry with its noise and smoke fills the horses generally with an uncontrollable terror, and they cannot be forced on to the bayonets. Besides, the fire of the infantry kills or wounds a number of horses and empties a number of saddles, which breaks the continuity of the line. A celebrated and familiar instance is to be found in the numerous and unsuccessful attempts by Napoleon to break Wellington's squares at Waterloo. Here, instead of charging in line, deep columns were formed, with the expectation that the rear horses, unable to see what was going on in front, would by sheer physical pressure drive the head of the column upon and through the sides of the squares. But the result was a complete failure. The horses which fell were stumbling-blocks for others following, and, when up to the squares, the wounded and terrified animals could not be forced to leap upon the firm array of bayonets, but either reared and fell in place, or fled in desperation towards either flank of the column, or tore their way to the rear.

The Prussian infantry at Sedan withstood and repelled charges of the French cavalry.

But when the ranks are disordered and broken the case is different; the horses seem to appreciate the circumstances of the case, and dash in with a good will. Few things are more terrible to a mob than a charge of dragoons!

Light Cavalry have no defensive armor, being, as a general rule, armed with saber and pistol only. Sometimes it happens that a portion or all of the men are provided with carbines. They are used on the field of battle for movements requiring speed, for protecting the flanks of the heavy cavalry, for pursuing and harassing a routed enemy, and for taking prisoners.

They are also used for escort duties, for reconnoissances, for outpost and picket duty, to forage, to levy exactions upon unprotected populations, to cut telegraph-wires, to destroy railways, etc.

In the army of the United States there are none but light cavalry. None of our neighbors on this continent keep heavy cavalry, nor is it probable that such will be brought against us from beyond sea. We rely upon our infantry and artillery to put those of the enemy in such a condition that they would be legitimate game for our light cavalry. At the battle of Cerro Gordo the slaughter inflicted upon the broken and flying Mexicans was frightful.

A **Dragoon** is a mounted musketeer, or an infantry soldier on horseback. This is the theoretical idea of a dragoon; practically the name is often applied to a *hussar*. The original design was to transport the men rapidly

to the points where they were required, there to dismount and fight on foot. But genuine dragoons are regarded as a failure. They are not prepared to fight as cavalry, and the speed with which considerable bodies can be moved is found not to exceed much that of well-seasoned light infantry, and they cannot get over ground which is quite practicable to the latter; besides, the services of all the men who are required to hold the horses while the others are fighting are lost, and when they become separated from their horses the latter are liable to be captured; or else the fear of it may recall the dragoons from their work to prevent it.

The regiment of mounted riflemen was organized upon this theory at the outbreak of the Mexican War; but during that campaign they acted as light infantry, and subsequently as light cavalry. Even the name has been abolished, and the regiment now constitutes one of the regiments of cavalry.

The **Hussar** is a light cavalryman armed with saber, pistol, and generally with a carbine.

It is very difficult to load a gun at the muzzle with a rammer while seated on a horse, for during the operation the rider necessarily loses control of his horse, the motions and restiveness of which greatly interfere with placing the cartridge in the bore, ramming, returning rammer, and capping. Besides, effective firing at long range can be done upon few horses and by few men. This would confine the useful fire of dragoons and hussars to a short range, where accuracy of aim was of slight consequence; under these

circumstances a repeating pistol with a heavy charge would be better.

Lancers are a kind of cavalry unknown in the United States service, but much used and highly esteemed in the Russian and Mexican armies. The French also have some lancers; and the lance is considered the distinctive weapon of the Poles.

The world-renowned Cossacks are an irregular light cavalry of the Russian service, armed with lances, pistols, and sabers. Some Cossacks are armed as dragoons, and some of the Russian cuirassiers have the front rank armed with lances.

The Cossack cavalry are remarkable both for the nature of the men and that of the horses. The rider and the animal are both wild, hardy, intelligent, extremely active, capable of much fatigue, thirst, and hunger; and either can manage to live and be highly efficient upon very slender resources. The Cossacks make extremely long and rapid marches. General McClellan, in his report upon the Russian cavalry, states that "a march of forty miles is a common thing; they will make forced marches of seventy miles; in a thickly settled country they have in two days made six marches of ordinary cavalry without being discovered." The latter fact also shows their stealthiness and cunning.

The lance was, for a long period, used by French horsemen, but was abandoned about the time of Henry IV. of France for the saber and firearms. At a time when battles were a series of individual combats, this was a sensible exchange, because, man to man, the saber would be better

than the lance; but at a time when the action of masses replaced these individual encounters, the case assumed a different aspect. If two lines of cavalry, equal in all other respects, were to meet, especially at the gallop, few would anticipate anything but victory for the lancers. Napoleon, by incorporating into his forces some Polish lancers in 1807, again introduced the lance into the French army, where it maintains itself, as above remarked, to the present time.

As Americans are fine riders and have good horses, it is very much to be desired that the lance should be tried in our service. It is certain that our troops in the war with the Mexicans regarded their lancers as the most formidable of their organizations.

The lance is an arm very valuable in pursuit, which consideration classifies lancers as light cavalry. The lance consists of a steel spear-head on a long pole or handle, which must be straight, while the head must be tough, oblong, pointed, and not bulky, so as to be able to penetrate the frame of a man or an animal.

The center of gravity should be at or near the gripe, so that the weapon can be accurately guided; and accordingly the butt-end of the pole should carry a counterpoise, so as to throw the center of gravity into the gripe.

Artillery. — Artillery is divided by the caliber of the pieces into *Siege and Garrison artillery* and into *Heavy and Light field artillery*. The first is used in the attack and defense of places. *Field* artillery is drawn by horses, and moves with the troops in campaign. It is of course much

lighter and more mobile than the former. The heavy field-batteries are batteries of position; they attain the enemy at greater distances than do the light, serve to destroy his cover, and often drive him from shelter. Light artillery, on the other hand, dashes about the field according to the varying exigencies of the conflict, and pours its missiles into the enemy's troops.

There are two kinds of artillery, *foot* and *horse artillery*. The pieces and caissons of each are drawn by horses, usually six to a carriage, but in horse artillery the cannoneers are mounted on horseback when not serving the pieces; whereas in foot artillery the cannoneers habitually follow the pieces on foot, and it is only when upon good ground and when the design is to move with great speed that they are allowed to mount and ride upon the boxes.

Horse artillery serves with the cavalry, and the foot-batteries with the infantry divisions. From the open and dispersed nature of its formation, horse artillery is not capable of efficient self-defense. Its value is in offense, and it requires to be protected from capture by the other arms; to this end it generally has an infantry support. La Vega's battery, which was captured by May's dragoons during the Mexican War, had no support. Horse artillery was invented by Gustavus Adolphus.

Field artillery is of great importance when the troops are raw and new to battle. A skillful general will place his few good troops on the points of attack, and protect the other points by massing strong batteries there. He will thus lend physical support to his less reliable troops, and encourage

them by the moral effect of the guns. On open plains, where it can move and fire in all directions, artillery is of high importance; massing strong batteries will supply the want of military positions, and the fact that these artificial military positions are movable is a great additional power in the hands of a skillful general.

In broken and mountainous countries infantry naturally plays the most important part, but even there artillery may be very useful to concentrate a heavy fire on a narrow defile, to shell and burn villages, demolish houses, etc.

Engineer Troops are sappers and miners, who open the trenches and conduct the approaches in a siege, who sap, undermine, and blow up the enemy's walls, and construct siege-batteries and mortar-batteries; pontoniers lay and preserve military bridges, and pioneers remove obstacles to the march of columns, such as fallen trees, etc., or steep declivities, or place obstacles in the way of the enemy.

Besides the various organizations above referred to, there are several staff corps to assist the general or to supply the troops. Of such are the Adjutant-General's Department, the Ordnance Department, the Subsistence Department, the Quartermaster's Department, the Medical Department, and the Signal Corps.

CHAPTER II.

SUPPLY OF ARMIES.

THE last chapter was devoted to examining the nature of the composition and organization of armies; in this let us investigate the methods of *supplying* them; for after an army has been organized, the next step is to clothe, equip, and arm it.

It will not be necessary for us to descend into very minute particulars, for there is no invariable rule upon these subjects, the practice and methods of accomplishing the object being different in different countries, and in the same country at different times.

Pay. — The pay allowed to soldiers and officers by the government is distributed to them at regular periods by the captains of companies or by the paymaster. In the United States service this duty is performed by paymasters, who usually have the rank of major, and who visit the various bodies of troops in their respective districts once in every two months.

The entire force is, on this occasion, *mustered*, i. e. paraded and inspected, and the presence of the different individuals belonging to it verified by calling the **Muster-Roll.** If any of the command should, by wounds or sickness, be

prevented from being present at the muster, the mustering officer visits the hospital or quarters and assures himself that there are present and in the command all those whose names are upon the muster-roll.

The only exception to this rule is in the case of persons absent by authority, such as those on furlough or detatched service; and in their case the orders and authority for such absence must be exhibited.

The pay delivered to the individual at the table of the paymaster is his own to dispose of as to him may seem good. There is no superintendence or control exercised over the disbursement of his money by any authority, as is the case in some of the services of Europe.

In the case of non-commissioned officers and soldiers the pay is over and above the allowance of Clothing, Quarters, Rations, and Fuel, all of which are furnished by the government. Arms are intrusted to the men to be by them used in the discharge of their military duties, but they remain the property of the United States.

The pay of a soldier of infantry or artillery is as follows: private, thirteen dollars per month; corporal, thirteen dollars; sergeant, seventeen dollars.

For the cavalry, engineers, ordnance, and special corps, a few dollars more per month.

There is, moreover, an *extra duty allowance* prescribed by law of Congress, for duties not contemplated as in the habitual routine of military exactions; such as those of laborers, teamsters, mechanics, etc., in the Quartermaster's Department. Moreover, for wounds and disabilities con-

tracted or received in service certain *pensions* are allowed by law.

In European services, as before remarked, a different practice prevails. For instance, in that of France, according to Mordecai, "the pay and allowances vary with the state of the troops, whether on *peace establishment, assembled for active service* (as in camps of instruction or preparation for war), or *in war*. The War Pay is uniform, but the compensation in time of peace depends on the individual position of the officer or soldier in actual service; such as whether he is stationary or on a march, present or absent from his regiment, on furlough, in hospital, in confinement, or a prisoner of war.

"There are also supplementary allowances for pay for peculiar circumstances; as for length of service, for traveling allowances, for residence in Paris, for professors and instructors in the schools, for recruiting depots, for table-money to certain commanders and others, commutation for quarters, forage, furniture, subsistence, payment for horses and property lost, etc.

"The soldiers receive only a small quantity of the pay for pocket-money (*centimes de pôche*); the expenditure of the remainder is regulated by the regimental council of administration, for their subsistence, clothing, repairs of arms, and equipments, etc. In each regiment a captain performs the duties of paymaster, and another those of clothing officer."

In the **Austrian Service** the internal administration of a regiment is conducted by the colonel, assisted by a captain and eight quartermaster-sergeants. This captain

has charge of the muster-rolls, and all accounts and requisitions and records of the regiment. He receives from the commanders of companies the requisitions for all kinds of supplies, and forwards them to the neighboring depots of supplies, where the requisitions are filled. He then delivers to each captain whatever is intended for his company, and that officer distributes the same to the men, and thus becomes responsible for the individual payments.

In the **Prussian Service** certain officials styled Intendants do the purchasing and the issuing of supplies, and disburse the funds to battalions and companies. They are delivered to the company officers and sergeants, who distribute them to the men. Materials for clothing are given to the men, who make up their own clothing. Bread is the only ration which is issued in kind; other provisions are purchased out of the pay or money allowance. This portion of the funds is administered by a company board composed of an officer, a non-commissioned officer, and a private, who are selected by the company.

The men are paid off every ten days, the funds being received by the paymaster, — who is a civil officer, — and turned over to the captain, in whose presence they are paid out to the men by the orderly sergeant. The regimental commander inquires of the men upon parade whether they have received their dues; and the same question is asked by the general upon reviews and inspections. Each soldier has a little account-book, in which is kept his account.

In the **Russian Service** the supply service is organized into various bureaus; such as the Subsistence Bureau, the Clothing Bureau, etc.

Subsistence Department. — In the United States service, in addition to the Pay Department, there are the Subsistence Department, the Quartermaster's Department, and the Ordnance Department, each of which is presided over by a brigadier-general stationed at Washington City.

The subsistence officers, who are styled commissaries of subsistence and assistant commissaries, purchase and distribute to the troops the provisions or rations in kind. To each regiment there is a regimental quartermaster, who also acts as assistant commissary of subsistence; and at posts where there is less than a regiment, a lieutenant who belongs to the command also acts in this capacity, over and above his ordinary duties.

These officers are in charge of the depot of subsistence stores, and issue the same upon proper requisitions by the captains of companies. And they are assisted each by a commissary-sergeant, and the rations are delivered to the orderly sergeants of companies, who distribute them to the men.

The principal ingredients in the ration of the United States army are eighteen ounces of flour, or one pound and a quarter of corn meal, or twelve ounces of hard bread; three quarters of a pound of pork or bacon, or in lieu thereof one pound and a quarter of fresh beef. Besides these, to every hundred rations are allowed eight quarts of pease or beans, or in lieu thereof ten pounds of rice; six pounds of coffee; twelve pounds of sugar; four quarts of vinegar; one pound and a quarter of adamantine candles; four pounds of soap; and two pounds of salt.

On a campaign, on marches, or on board of transports, the ration of hard-bread is one pound.

The above is a sufficiency of substantial and wholesome food; in fact, a generous provision. In addition to such parts of the ordinary ration as may be used in hospital, certain delicacies are allowed to the sick upon the requisition of the surgeon.

The **Russian Ration** consists of two pounds and three quarters of bread, half a pound of fresh meat, salt, oatmeal, cabbage, and some brandy. Of this, the bread, the brandy, and one fourth of a pound of meat is furnished by the government, and the residue is bought from the *artel*, or company mess fund. This fund is created by a certain amount taken or stopped from the pay of the men, — from the wages of the men when doing extra duty, or when working for persons in civil life. The authorities encourage these labors, and the whole proceeds are turned into the *artel*.

The Russian soldiers eat three times a day. Breakfast is made of bread and salt and a little brandy; at one o'clock they dine on bread, and soup of meat, with cabbages intermixed; the supper, which takes place at four o'clock in the afternoon, consists of the same bill of fare as the dinner, with the addition of oatmeal porridge.

The bread, which is coarse and brown, is sour. The soup also is sour; but this ration is said to be healthful. Each man has a wooden spoon, and every mess of six men a wooden bowl out of which they eat in common.

The **Austrian Ration** is mainly made of bread and soup.

Each man receives daily from a pound and a half to two pounds of bread, and an allowance of about ten cents to buy meat, which is usually a quarter of a pound in amount; also some vegetables. In garrison the men have soup once a day, at midday; and for breakfast and supper they buy at the sutler's a piece of bread and a small glass of brandy.

The **French Ration** was during the Crimean war, according to General McClellan, as follows: "One pound ten and a quarter ounces of bread, or one pound three and a quarter ounces of biscuit; one and five hundredths ounces of rice or beans; two and one tenth ounces of the Chollet prepared vegetables; eight ounces and three quarters of fresh meat or salt beef, or seven ounces of salt pork; forty-four hundredths of a pint of wine, or eleven hundredths of a pint of brandy."

Sometimes sugar and coffee are issued. Each mess of five men in the cavalry had their cooking utensils, which were carried strapped to their saddles. These utensils were the *marmite,* or camp-kettle; the *bidon,* a pan for bringing water; the frying-pan, and the *gamelle* or cup.

The **Prussian Ration,** when the men are in garrison, is one pound and a half of black rye-bread, which is issued every four days; and it must have been baked at least twenty-four hours before issue. To this is added a small money allowance with which the remainder of the food is purchased by a commission of officers and non-commissioned officers. When the troops are on a campaign, the ration at its maximum consists of half a pound of meat;

two pounds of bread or one pound of biscuit; one sixth of a pound of rice, or quarter of a pound of peeled barley, or half a pound of beans or pease, or one pound and a quarter of potatoes, with half a pint of brandy.

Supply of Clothing and Equipage. — In the United States service the clothing is made up complete before issue, and is generally purchased from contractors. As a general rule the clothing is of excellent materials, being subjected to a rigid scrutiny before being accepted; but in time of war, when all the peace regulations are relaxed, and when the supplies must be upon an enormous scale, the materials are often of a very inferior quality, and the dishonest and swindling contractor has an opportunity of growing rich upon his fraudulent gains. The public and general recognition of this truth is evinced by the popular epithet, "shoddy rich," "shoddy aristocracy," etc.

The allowance of clothing for five years, the term of enlistment, is seven caps, two pompons, two eagles and rings, five pompon-covers, eight coats, thirteen pairs of trousers, fifteen flannel shirts, eleven pairs of drawers, twenty pairs bootees, twenty pairs stockings, two leather stocks, one overcoat, one stable frock for cavalry, five fatigue overalls for engineer and ordnance soldiers, and two blankets.

This allowance is found to be more than sufficient for the neat, thrifty, and economical; and as all are required to be well and neatly clad, all surplus articles issued beyond the above allowance are charged to those

men who overdraw, and the amount is deducted from their pay.

One sash is allowed to each company for the first or orderly sergeant, and one knapsack with straps, haversack, and canteen to each enlisted man.

Commissioned officers purchase their own clothing from their own purses.

Besides clothing for the men, there is an allowance of camp and garrison equipage for the troops as follows: —

Tents while in the field, —

For a general officer	3
" " staff officer above rank of captain and for field officer	2
" other staff officers and captains	1
" subalterns of a company, to each two	1
" 15 foot or 13 mounted men	1

and to the latter two spades, two axes, two pickaxes, two camp-kettles, five mess-pans, and two hatchets. A proper allowance of axes and hatchets is also made to the officers' tents.

Bed-sacks are furnished to the troops in garrison. Flags, colors, standards, guidons, drums, fifes, bugles, and trumpets are also issued. Forage, fuel, and quarters are supplied to the troops in garrison, — forage in the field sometimes.

All of the above supplies are furnished by the Quartermaster's Department, which does the bulk of the disbursements for the army; it being charged with all the transportation of the service, the purchase of animals, the erection of quarters, barracks, hospitals, etc.

Medical Supplies are furnished by certain officers of the Medical Department, called medical purveyors, upon the orders of the Surgeon-General, who is stationed at Washington City. These supplies are medicines and drugs, dressing, bandages, hospital furniture, surgical instruments, etc.

The Ordnance Department has charge of the arsenals and armories, and furnishes all ordnance and ordnance stores for the military service, and, to some extent, to the militia of the several States. The officers of this department on campaigns frequently have command of siege and mortar batteries.

The general term "ordnance and ordnance stores" comprehends all cannon, artillery-carriages, and equipments; all apparatus and machines for the service and manœuvers of artillery; all small arms, accouterments and horse-equipment, all ammunition, and all tools and materials for the ordnance service.

The commander of every company or detachment is responsible to the government for all the arms, equipments, and ammunition issued to his men.

The clothing of the *French army* is so nearly like that of the United States, that it is needless to say anything of it here.

That of the *Austrian* service is well made and of excellent material. It is issued to the squadron captains, either made up without being trimmed, or merely in the shape of raw material, according to their option. The overcoat for all the cavalry is of thick white cloth, with sleeves and a

long cape; it is made very long and loose. From this same white cloth the coats of the infantry is made. It is cleaned by washing and pipe-clay, and is in favor with the troops. They have no tents, nor do they carry any blankets while in the field.

The clothing of the *Prussians* is similar, except the color; they wear frock-coats, of dark blue generally. The distinctions of rank, army corps, regiment, etc., are found on the cuffs and collars. Each soldier has in his knapsack one pair of cloth pants, one overcoat, one forage-cap, one pair of shoes, one pair of extra soles, one shirt, one pair of drawers, brushes, shaving-materials, and twenty rounds of cartridges; the weight of the whole is about twenty pounds; and the entire load of the soldier, including arms, accouterments, ammunition, etc., is about sixty pounds.

It is needless to dwell upon the supply of armies, for the methods of procuring, distributing, and repairing the various kinds of supplies needed by an army will be varied by the circumstances of the country and times. It is a matter of prime importance, however, to every nation, and affords a field for the exercise of a faithful economy, administrative ability, and business tact.

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CHAPTER III.

MOVING OF ARMIES.

AN army being organized, well equipped, and supplied, and a proper proportion of the various kinds of staff officers and staff troops assigned to it, and it being supposed that it has been thoroughly taught in the department of tactics, it may be considered ready to move into the field.

An army may be transported by vessels at sea, or by boats upon rivers; it may be transported by railways on land, or finally it may march. The last is, of course, the most usual method. When the march is to be made in our own or in a friendly country, the case is quite different from a march in the vicinity of the enemy; the numerous precautions to be taken in the latter case not being necessary in the former. The troops are sent forward in smaller detachments and at greater intervals; they may also be sent by different routes, which need not be very near to each other, the governing considerations being comfort and economy. Single regiments would be convenient bodies to send forward at a time.

A small advanced-guard should be sent ahead, sufficient to remove obstacles to the march of the main body, to make arrangements for crossing rivers, to select camping-places,

and to make other needful arrangements. A rear-guard should follow at a suitable interval of time to pick up stragglers.

The men are allowed to take the route step and to march at ease, carrying their pieces (which are not loaded) at will, but generally at the slope. They advance along the roads in *columns* of platoons, or with a smaller front, as by *sections* or by *fours*, according to the width of the road. When passengers are met on the road, the troops must leave sufficient space for their passage. On good roads the troops should make at least two and a half miles per hour. The officers must remain at their posts during the march, and maintain general good order, without, however, requiring silence or exacting any observance that would be fatiguing to the men. After marching an hour, a halt of ten minutes should be made, and another of one or two hours midway of the march.

The spots where halts are made should never be in towns or villages, but in the vicinity of water; and the ground should be dry, so that the men can lie down, because in this way they will rest more rapidly and completely than in any other posture, and they will thereby preserve their strength. When the halt is for more than ten minutes, they should stack arms and take off their knapsacks and accouterments, hanging them on the stacks.

Throughout the march the officers should take advantage of every opportunity which presents itself to rest their men and allow them to remove the weights which they may be carrying, resuming them only when ready to set out again.

But in the *neighborhood of the enemy* many precautions will be necessary. Larger bodies will march together and on different roads only when they are near to each other and no barrier intervenes which would prevent one body of troops from coming promptly to the relief of another. They must also have adequate advanced-guards and rear-guards, with patrols at considerable distances from these, and also from the flanks of the columns to prevent ambuscades, to find the enemy at sufficient distances to enable the general commanding to make dispositions either to move on to the attack or pursuit, or to receive the enemy's attack.

When there is a necessity for all or many of the troops to move by the same road, the different regiments and brigades should be separated by intervals sufficient to prevent crowding and the consequent loss of time. The nature of the locality must regulate the size of the intervals; generally they should be about seventy-five yards between regiments, and one hundred yards between brigades; on the other hand, the intervals must never be so great as to prevent a prompt concentration of the command before an enemy could make much headway in an attack. Artillery marches by sections or by piece, and cavalry by twos or by fours. The part of the rear-guard, on a retreat, which is nearest to the enemy, should *march by the rear-rank*, so that they can promptly face to the rear and deliver their fire.

It has been remarked above that when marching near the enemy, advanced-guards, rear-guards, and flank-guards should be thrown out to prevent being surprised by sudden attacks. The advanced-guard should, as a general

rule, be from *one fifth to one fourth of the whole force.* Its duty is to discover the enemy and to send in information of his strength, kind of troops, locality, and apparent design. After once discovering the enemy, they must never lose sight of him in case he retires; on the other hand, should he approach, they must hold him in check at least long enough for the main body to prepare to receive him. They should examine the nature of the country in advance of the main body, removing obstacles and sending back all information that may be useful.

The advanced-guard should be sufficiently far ahead to allow time to the main body to form before the enemy can come upon them. Accordingly, if the advanced-guard is pretty strong and independent, it can afford to go farther ahead than a weaker one could do, even up to the point of putting half a day between itself and the troops following. In smaller bodies which do not require much time for formation, the advanced-guard should not separate itself more than two or three miles.

The advanced-guard should have an advanced-guard of its own of two companies, one company, or a platoon, according to strength. During the late war between Prussia and France the armies of the latter seem to have been singularly deficient in good guards for the head, rear, and flanks of their columns. Outpost service generally seems to have been ill-performed or totally neglected. At the retreat across the Moselle, the French army while *en cheval,* or astride the river (i. e. part on one bank and part on the other) were surprised and struck, not by the

Prussian advanced-guard, but by a large body of the main army!

The advanced and flank detachments move at a distance of eight hundred or one thousand yards from the main advanced-guard, and these detachments send out patrols who march five hundred to one thousand yards from the heads and flanks of their detachments.

They must never lose sight of each other, and thus form a complete chain around the head and flanks of the advanced-guard.

In a **retreat** the advanced-guard has but a subordinate part to play, the main and important thing being the **Rear-Guard.** They have to preserve order, to remove obstacles, and to prevent straggling and running away, etc.

But to a *rear-guard on a retreat* belong some of the most difficult as well as most important duties ever devolving upon troops. They must do everything to fend off the enemy from the main body, and allow it to continue its retreat quietly and unmolested. To this end they must destroy bridges, ruin fords, fell trees, and seize every favorable spot on the route to inflict loss upon the pursuers. It should be stronger than an advanced-guard when marching towards the enemy, because, if this body should be beaten and driven in, it can fall back upon the main body, or else the main body can advance to its relief; but it would never do to allow the rear-guard of a retreating force to be broken and driven in confusion upon the main body; it might, and probably would, involve the rout of the whole army.

History is full of examples of the conduct of rear-guards; but perhaps the most celebrated and interesting was that of the grand army commanded by Marshal Ney on its retreat out of Russia.

If the enemy pushes us vigorously and in force, our rear-guard should be strengthened even to *one third the whole force*, so as to allow a greater interval between it and the main body. When the army retreats in several columns, the different rear-guards should keep up a constant communication with each other, and keep on a general line perpendicular to the direction of the march, so as to prevent the enemy penetrating the gap made by the one which should have moved farther on, and thereby taking some of the other columns in flank. With both advanced and rear guards there should be a proper allowance of pioneers or mounted engineer troops, to remove or place obstacles, etc.

If defiles are to be passed in retreat, sufficient time and space must be allowed to the main body to get through safely and without precipitation.

Flank-Guards. — A flank march is a critical, dangerous operation in presence of a vigilant enemy; and yet the advantages are generally so great when it is successfully accomplished, that it is very tempting. There should be thrown out a strong flank-guard on the side of the enemy, and *they* should have flank patrollers farther on, who could give timely warning of his approach to the flank-guard, which should immediately make effort to check and delay him until the main force can form in order of battle. If, at this moment, we have left one communication and have not reached others, the situation is highly dangerous.

The whole force should be so arranged as to be able to make the most speedy formation in line of battle; and there should be parallel columns which could form first, and second lines, reserves, etc. The particular corps which are to form these various bodies should be designated beforehand, and made acquainted with the part they are to play. The trains, baggage, ambulance corps, etc., should be, of course, with the column farthest from the enemy.

Trains. — To avoid confusion and delay in the march of troops, arising from the large number of wagons with them, the trains should be divided into *three classes.*

The trains of the first class which are needed during the march consist of the ambulances provided with the means of dressing wounds; they should be accompanied by some surgeons and hospital attendants. When in the immediate neighborhood of the enemy, the ammunition-wagons should be in this train, so that the men may not fail to have plenty of ammunition. If rivers are to be crossed, the ponton train also should accompany it. These trains of the first class follow immediately after the regiments or organizations to which they belong.

Trains of the second class consist of such as are needed by the troops only when in camp. They comprise wagons for ammunition, money, papers and records, tools, baggage, medicines, field-forges, artillery-wagons, pack animals of the field and company officers, wagons of the office of the commander-in-chief, wagons carrying provisions and forage for immediate distribution, and the suttlers' wagons. Ammunition-wagons are kept by themselves, and march

near the troops. Trains of the second class follow the main body in the interval between it and the rear-guard. In a general retreat the wagons of this class should be sent at least half a day ahead, so as not to impede the progress of the troops.

Trains of the third class are composed of those for which *there is no pressing necessity*. They consist of the commissariat-wagons, those of the general hospital, reserve ordnance stores, etc. Trains of this kind follow by themselves under an escort.

To prevent delays from a wagon breaking down, large trains should move in sections of about one hundred wagons each, and these sections should march at a distance of about one third of a mile.

Of Halts. — The length of a march near the enemy varies with circumstances. Ordinarily it will be about seventeen miles, but if necessary it may reach thirty miles. Small detachments, of course, move with more celerity than large ones or entire armies. Forced marches should never be made without some highly important object. Small detachments of cavalry may march forty, fifty, or even seventy miles under a great pressure. The ordinary rate of march is about three miles per hour; short halts of ten or fifteen minutes should be made every hour.

When a halt is made for the night or a longer time, in order to prevent being turned, detachments and pickets should be sent out on all the roads leading from the flanks. During a long halt, or one for the night, the train is arranged more compactly than usual; a proper position is

selected in which to place all the wagons together, in order that, being less scattered, a better watch may be kept upon them. When danger is apprehended from the enemy, it is best to park the train in column, because this formation is changed more rapidly than any other, and from it it is easier to take the road at the end of the halt, or when leaving camp. An average interval of eight yards in width is allowed to each wagon in this formation. The harness is either piled up behind each wagon, or is hung upon the wheels, and the animals are tied to the tongues or poles. The distance apart of the different rows of wagons is twenty paces.

Wagons having powder in them are placed apart, and are carefully guarded against fire and disturbance. The escort bivouacs on the flanks or at the head of the train; sentinels are posted. If the teamsters are not to be trusted, or desertions are apprehended, a chain of sentinels should surround the whole train. When an attack is expected, the wagons should be parked with the hind wheels outside and the animals within the enclosure.

Commander-in-Chief. — The commander-in-chief who designs to make a march which will be in the vicinity of the enemy must be thoroughly acquainted with the roads and general topographical features of the district.

He must send forward staff officers, patrols, or scouts, to examine and report to him all the desired information; but if the enemy occupies such positions as to forbid this, he must have recourse to the best maps to be procured, and supplement this information by interrogating the inhabitants and deserters.

The Prussians, when they entered upon the late campaign in France, were possessed of complete and detailed maps of all the territory which they expected to operate in; and they were never at a loss, but seem in some instances to have been better posted than the French commanders themselves.

Moreover, the commander must have guides to pilot the different columns; he should procure — seize if necessary — such men as, by the nature of their occupations, are well acquainted with the country, — hunters, mail-riders, stage-drivers, collecters of revenue, census-takers, etc. These guides must be closely watched, for fear of treachery; they should be kindly treated, and informed that, if their service is well performed, they will be generously rewarded, but that, at the first sign of treachery, they will be shot. When their service is over they must be sent back to the rear, and precautions taken against their going over to the enemy.

In his orders for the programme of operations, he must avoid descending into particulars so minute as to embarrass subordinate commanders, should any event which was unforeseen transpire. But those orders should distinctly specify what troops and organizations are to form certain columns; who is to command them; what they are to do; by what roads to move; the time they must arrive at designated points; and where he himself can be found at various designated hours. He should send his trains by routes that will not be needed in case of a check and consequent retreat. He must provide a continuous communication between the different columns, so that each shall know of the progress of

the others. In a retreat the rear-guard, and upon an advance the advanced-guard, flankers, and all detachments near the enemy will have their pieces loaded, but be careful never to fire without orders from competent authority. The main body do not load until about going into action.

During secret marches at night no drum or bugle must sound, all orders must be given in a low voice, and as little noise as possible of any kind be made, while no fires or lights should be allowed, no one should even light a pipe. Advanced-guards, flank detachments, and patrols should be frequently relieved by fresh troops, because they become fatigued by constant vigilance and anxiety.

Commander of the Advanced-Guard. — He sends out front and flank detachments as soon as the march begins, as was explained above. An officer or a non-commissioned officer is placed in command of each detachment, with full instructions as to what he is to do, and how to proceed in the supposable cases likely to arise. The commander of the advanced-guard sees that all these parties maintain constant communication with him and with each other.

When he receives deserters or takes prisoners, he must question them minutely as to the regiments they belong to, where they are, the strength of their guards, the number and position of the enemy, what corps and divisions are near their own, and by whom commanded, the number of the sick and wounded, the quantity and position of their supplies, and in general everything that may be serviceable. But all such information must be received with distrust; these persons may deliberately falsify, or they may be so

ignorant that their information may be worthless. Sometimes it happens that timid persons will answer in the way they suppose the questioner's wishes run.

It is necessary frequently to repeat the same question unexpectedly, so as to compare the different answers and the answers of different individuals to the same questions.

Everything at all remarkable should be reported by the commander of the advanced-guard to the general; such as his arrival and departure, and the time thereof at ferries, fords, villages, and, of course, any news of the enemy. He should be careful not to send light and improbable rumors, but investigate and verify in person as far as possible all reports which he makes.

Upon entering a town or village, he should have the authorities and principal persons brought before him, and he should seize the public documents, post and express offices.

As a rule, he should send an aid-de-camp or intelligent officer; he may, if desirable, write in pencil, using a cipher, if there is fear of the paper falling into the enemy's hands. These reports should be clear, precise, explicit, without verbosity, and should show what is known to be fact and what is upon hearsay.

These and all similar reports should be numbered in a series, and the date with the hour accurately given, so that the general may not be misled into believing that old information is new, because it frequently happens that the *last* report reaches its destination before one that was despatched previously. If a report is very important, and

there is fear that the enemy may get it, or of delay from any cause whatever, another copy ought to be despatched after the lapse of a suitable time.

When the enemy is encountered, instant information of the fact is sent to the general; meanwhile the commander of the advanced-guard makes those dispositions called for by the circumstances of the case. If strong enough, he should advance and fall upon the enemy; but if this is not deemed expedient, he may take up a position where he can hold the enemy in check until the arrival of the main body; or if he cannot do this, to avoid being cut off, he must fall back towards the main body, delaying the enemy by all such means as have been heretofore indicated, and by such others as may be suggested by the fertility of his own genius, the time, and circumstances of the case. He must in no case allow the main body to be taken unawares, or in the confusion of forming for battle.

The **Selection of Camps** for the advanced-guard is a matter of high importance; positions strong and not liable to surprise must be selected, if such are to be had. Cities and villages are not good for such a purpose; the attention of the men and officers may be distracted from their duties, and intoxication may spread among the men; besides, so good a watch cannot be kept up, and all that transpires in the command may be reported to the enemy, together with its strength, composition, and designs. There may be, however, good reasons for occupying the place by a detachment, which is sometimes done.

Should the advanced-guard camp near a defile, its open-

ings or debouchés should be held; and it may be well in some cases to advance through the defile and camp at its farther opening. Whatever has been here said applies equally to a flank-guard thrown out on a march to the flank. It may be well to remark, parenthetically, that one of the greatest dangers of a flank march arises from the fact that we of necessity abandon our lines of communication with the rear; all secrecy and diligence must therefore be used to gain another before the enemy can strike us. *On a retreat,* the commander of the advanced-guard is charged with preparing a good line of march for the main body, removing all obstacles, preparing the banks of streams, repairing or making bridges, and collecting the needed supplies for the use of the army.

Commander of the Rear-Guard in Retreat. — His duties, as before intimated, are among the most arduous and most responsible which a military man is ever called on to perform. He will be compelled to fight, it may be almost perpetually, and always with the great moral disadvantage of a retreat; he fights, not for victory, but for safety. Upon him devolves the task of sustaining the courage and spirits of the army, of preventing loss of men and materials left behind, of supplying himself and the commanding general with thorough current information of the enemy and his movements. He must throw out flankers, and scour the neighborhood of his flanks.

It may be that the enemy will hasten forward troops on the flanks, either with the view of turning the rear-guard, and getting between it and the main body, to cut it off, or

else to harass the rear-guard by urging it, from the fear of such a catastrophe, into a rapid and confused march. Wherever there are roads affording facilities for such a movement, they should be thoroughly explored, and, if needful, held in strength sufficient to thwart or delay it.

If in sight of the enemy, and fighting, he should not wear out his command by marching or fighting the whole of it at once; but rather he should hold positions with part of it, while the remainder fall back to other positions, and when they have been occupied, that nearest the enemy may be abandoned, and so on. No obstinate contests should be engaged in for the defence of such positions, nor any useless fighting at any time; he must economize his command, and remember that his only object is to protect the retreat of the main body.

Every available means of retarding the enemy must be utilized, such as burning and blowing up bridges, destroying fords, filling up ravines with large stones tumbled down from the cliffs above, felling trees, etc. If a road in a ravine is cut out of the side of a cliff, by digging a pit in the road and putting some powder in it, a portion of the road may be blown away, and the enemy detained a long time.

Duties of the Commanders of Flank, Advanced, and Rear Detachments. — It will be remembered that it was mentioned that the rear, flank, and advanced-guards threw out detachments to march at a suitable distance from them; and that these minor detachments, in their turn, sent out squads of fifteen to thirty men, called *patrols*. In the day-

time, or on clear nights, they precede their detachments, and, forming a chain around the heads and flanks of the advanced-guards, sweep over and examine the whole country in the vicinity of the line of march. In an open country they can afford to spread out to a greater extent than when the case is different. Cloudy and thick weather and obscure nights will of course diminish their intervals. The object of their being sent out, which is to explore the country, will regulate their number and frequency. They must at all times keep in sight of, and in communication with, each other. If the night should be very dark indeed, the patrollers could not operate, and therefore should not be sent out.

When patrollers are sent out, the commanders of detachments should instruct them in their duties and what places to examine particularly. Especially should defiles, woods, and villages be examined by the patrols before the detachments venture into them; otherwise they might be surprised and cut off. Every person met on the road should be closely interrogated as to himself, and as to what he may know of the enemy. It will sometimes be well to detain him awhile, lest he should go to the enemy.

Upon drawing near a town or village, one or more of the inhabitants should be seized and questioned about the enemy; whether he is concealed in the town or its neighborhood, or whether he has been there lately, and when and where he went, etc. The persons who have been seized should be detained until the detachment has entirely cleared the village. The commanders of these detachments ought

never to send in any important report received from the patrols until they have verified it in person.

In the early part of the late campaign in France, the Prussians debouched in force from a wood during a battle, and caused the defeat of McMahon's army.

The officer, whose duty it was to have caused that wood to be searched, neglected it; and, as we were informed by the telegraph, overwhelmed with chagrin and self-condemnation, he dismounted, shot his horse, and committed suicide by advancing steadily and alone upon the enemy, till he fell, pierced by a bullet.

The detachments must keep up a constant communication with each other and with the guards to which they belong; they should beware of getting separated for a long time from their guards by impassable obstacles, such as marshes, lakes, and woods. But when the separation would not be too long, it is well for them to march on the outer side of these obstacles, so as to examine the country beyond.

When the enemy is found in force, or makes an attack, the commanders of these detachments should decline combat, and should retreat, while skirmishing, upon their respective guards. Of course they should do whatever can be consistently done to delay the enemy, and to gain as much time as possible.

Should the enemy stand fast, they remain in his presence, and if he retires they pursue, keeping him in sight.

Duties of Patrols during a March. — Patrols are of different strength; their business is to examine the country

near the line of march, and to discover the enemy so early as to prevent a surprise. Patrols ought to have at least ten or fifteen men in them. The men must stretch out as much as the nature of the ground will permit, both to examine as great an extent of ground as possible, and to prevent all being captured at once. Some should always be able to escape and to take in information.

The men in front, on the flanks, and in the rear of patrols are called **Patrollers.** At night they must close in on their respective detachments, but still keep up a chain, for fear the enemy should slip through in the darkness.

When a detachment is sent forward with orders to attack, it should keep its patrols and patrollers closer in, to prevent giving the enemy warning too long a time before its arrival at his position.

The individual patrollers must exercise extreme vigilance, keeping their eyes and ears open. Whatever they see and do not thoroughly comprehend, they must visit and inspect; and so of sounds, particularly at night; such as the giving of commands, noise of wagons, neighing of horses, tread of numbers of men, etc. If these things are not within the limits of their assigned inspection, they must inform a non-commissioned officer, who will take measures to investigate the matter. The detachments and patrols ought then to halt, making the necessary dispositions against surprise. Patrols ascend every eminence on the sides of the route, and remain there until relieved, or until the detachment has passed.

Particularly on entering ravines or defiles with precipitous sides the summits of the sides should be carefully examined before the detachment enters.

If a report is to be made concerning anything seen or suspected, there must be no trepidation of manner nor loudness of voice; the communication should be in a low, calm tone.

When ascending a hill, one man should go in front of the others, and steal up quietly, moving behind trees, stumps, rocks, or any accidents of the ground, and when near the summit should take off his cap and cautiously peep over to see, without being seen. If mounted he should dismount.

When, in daytime, it is necessary for the advanced-guard to pass through a village, the front patrollers send one of their number into the village, who traverses its principal streets, asking for the chief man of the place; at the same time other patrollers ride along the outskirts of the place. When the magistrate or principal man of the village has been found, he is conducted to the commander of the advanced-guard, which will by this time have arrived. If it is night-time the patrollers approach the first house, call out the owner, and carry him off to the commander, as above; afterwards they seek the principal man of the place.

Precautions should be taken upon entering a wood; the skirts should be examined to ascertain whether the enemy is not ambuscading there, and the roads leading through must be scoured; and while advancing through a forest, if the

front patrollers come upon a prairie or open space, they must examine the skirts all around.

When our patrols discover those of the enemy, or when flags of truce come in, the commander of the patrol is immediately informed of the occurrence. The bearer of the flag is blindfolded and conducted to the commanding officer. If straggling soldiers of the enemy are perceived they must be surrounded and captured. When the enemy is found in force, a well-conducted and orderly retreat is made upon the detachment. It is only when the enemy suddenly bursts upon the patrollers that firing should be allowed, for the purpose of giving warning. At the first shot the detachment forms and the patrollers fall back upon it.

In reference to being surprised, — after remarking that such a thing should never happen at all, — it may be well to state that there are scarcely any circumstances which would justify an officer in the surrender of cavalry; a bold and instantaneous charge will always enable the majority to escape.

Regulating Marches by the Nature of the Ground. — When near the enemy it is usual to employ troops of all arms in the advanced-guard. If we expect to do any fighting we want infantry, artillery, and cavalry, in order that the excellences of each may be utilized as the opportunity offers. If the country is level and open we use more cavalry than when it is rough and covered with forests; light cavalry are used for this kind of duty. The army advances in several columns on different roads, the bulk of the troops destined for duty as advanced-guards march on

one road, while smaller guards march upon the others, and a mutual communication is kept up by means of patrols.

When the advanced-guard is composed of different arms, its distance from the main body depends also on the following considerations: 1st, its composition, cavalry advancing farther than infantry; 2d, the kind of country; for if the advanced-guard is secure from being turned, it may venture farther ahead; 3d, the object in view. If the main body expects to stand on the defensive, the advance should be well ahead, in order to give time for formation. But if the main body has found a position favorable to making a stand, there is no need of an advanced-guard at all; some pickets and videttes, to give notice of the enemy's approach, will be sufficient. When *pursuing* the enemy, the main body must be close behind the advance. Generally the distance of the guard in advance should be rather greater than the distance apart of the extreme columns of the main body.

In a mountainous country the patrols are infantry, and so, likewise, are the head and the rear of every column; the cavalry and artillery marching in the center. In mountainous countries we are most likely to be attacked, and it is here especially that the enemy will desire to fall upon our cavalry, for upon such ground, being unable to charge, it is quite helpless.

This is pretty much the truth also with regard to artillery; hence infantry is the sole reliance: it must protect the other arms.

To this end infantry patrols are sent out as far as practi-

cable to occupy the heights overlooking the line of march. Those of the advanced and flank guards hold their positions till relieved by those of the rear-guard.

The order in which the main body marches must likewise be adapted to the locality. In a mountainous country or in forests the cavalry must *not* be at the head of the column; because, if attacked there, they will probably be cut to pieces, and, in flying to the rear, will carry disorder among the other troops. And so with artillery; still, a few pieces can, with advantage, accompany the advance of the column, to play upon the enemy if he attacks suddenly.

The duties of the rear-guard have been more or less described above; not much need be added here. If the locality will permit, it is composed of all arms. In a champaign country the cavalry, by its charges upon a pursuing enemy, can keep him off until the infantry have time to fall back to woods, hills, or other strong positions.

But while *retreating through a broken country* the cavalry should be at the extreme rear (now the head of the column). On passing over a bridge or through a defile, some guns should be stationed at its mouth, along with the infantry, to keep the enemy aloof while the other troops pass through. After a defile has been passed and the enemy is following through it, then is a fine opportunity to concentrate a heavy fire from an extended front on the head and flanks of his column as it debouches, while he can do little in the way of retaliation.

If we must retreat through a hostile village, it should first be seized by infantry, and then the cavalry can either move

round it or gallop through, provided this last would not interfere with the fire of the infantry. Once passed, they and the horse artillery form to protect the infantry, as they emerge from the village.

The commander of the rear-guard must regulate always his own movements by those of the main body; being careful not to retreat too soon or too hastily, for fear of coming upon it and spreading confusion.

CHAPTER IV.

PASSAGE OF RIVERS ON ICE, BY FORDS, BY BOATS, AND ON RAFTS.

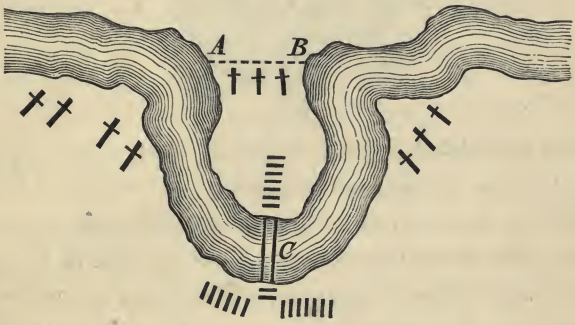
CERTAINLY one of the most difficult and dangerous of all the operations which troops in a campaign are ever called upon to perform is the passage of rivers, especially in the presence of the enemy or in his vicinity.

It demands from the commander the highest qualities of discretion, secrecy, promptness, and audacity; and from the army absolute obedience, silence, and coolness, together with a certain amount of mechanical skill and business tact.

The first considerations to be weighed are those of strategy, for the *selection of the point of crossing* is of prime importance. If our army is *in retreat,* we should select a place where the river makes a sharp and deep bend *away from us,* as is represented in the figure on the next page.

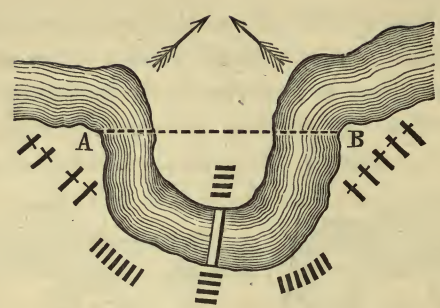
Here the short chord of the arc *A B* can be seized, and by a comparatively small portion of our forces, while the main body of the army makes the passage. This chord, strengthened if practicable and necessary by a hasty intrenchment, and mounted with sufficient artillery, will be a stronghold from which a heavy fire can be concentrated on the enemy to keep him aloof.

As soon as possible the greatest amount of long-range cannon that is available should be sent across, which will immediately take up positions on the banks opposite to *A* and *B*, whence they can keep up a cross-fire in front of the chord *A B*. These positions should be re-enforced as fast



as the troops cross, — which they do at *C*, — and finally the rear-guard can withdraw from the chord and make the passage under cover of the main body, now already across, and who will keep up a concentrated fire across the river. The last of the rear-guard will detach the bridge from the enemy's bank, destroy the ford, or do whatever shall be found practicable to defeat or delay the enemy's passage.

On the other hand, to cross over to the enemy we must select a point where the river makes a deep and sharp *bend toward us*. By throwing forward strong detachments on our flanks to the points *A* and *B* (p. 60) we can keep the enemy away from the point of crossing; for he would be chary of venturing into this *cul-de-sac*, where his troops



would be huddled together, with both of his flanks exposed and his own fire rendered divergent.

These, then, are the features of rivers which would decide our choice; but other advantages should be combined with them, if possible. We should avoid boggy land, or places where the animals and vehicles are liable to mire down. The approaches ought to be clear, firm ground. Should there be no choice in this matter, engineer troops must precede the main body, to remove obstacles and remedy the bogs by throwing in fascines or making the kind of causeway called *corduroy*.

If we have to *cross to the enemy*, we must by all means deceive him by making feints of crossing in several places at once, and conducting our genuine attempts at night and with great secrecy. When *retiring before the enemy*, we can accomplish very little in the way of deception. The spot being once fixed upon, it will become a question as to the *mode* of crossing. And this task may be effected by swimming, in the case of light cavalry and infantry, with bodies of troops quite considerable in numbers, by ford-

ing, by ferrying over in boats, by rafts, upon the ice, by flying bridges, or by ponton bridges. To decide in this matter, the general must have been thoroughly informed about the river by his staff officers. In addition to the facilities presented by the point of passage, or which may be collected along the river, — such as boats, and timbers for making rafts, — every well-appointed army will have appliances in its trains for crossing rivers. Such has been the custom from remote antiquity. It is said that Semiramis, in her expedition to the India, carried along boats which could be taken to pieces for transportation. Xerxes, we know, caused an immense bridge of boats to be thrown across the Dardanelles. Boats, rafts made of forest-trees, or the skins of animals sewed up and expanded by air, have been in use for the passage of rivers by troops from the earliest times. Julius Cæsar carried with his armies boats made of osier frames covered with leather or raw hides. The Emperor Julian made use of similar boats to construct his bridges for crossing the Tigris and the Euphrates.

Julius Cæsar constructed across the Seine a bridge, the supports of which were gabions filled with stones; and his bridge over the Rhine was on piles, protected by a row of piles, or a stockade, on the upper side, to fend off heavy logs and floating bodies which the Germans sent down the stream to destroy it. In more modern times Charles the Bold passed the Seine near Noret on a bridge of casks. In 1589 Alexander Farnèse cast three bridges over the Meuse near Bessel. A very celebrated bridge was that

constructed by the Spaniards in 1585 over a stream near Antwerp, and which came near being destroyed by an infernal machine invented by the Italian engineer, Jeunibelli. In 1631 Gustavus Adolphus crossed the Lech on a trestle-bridge in the presence of his enemy. In 1672 Louis XIV. had two bridges over the Rhine supported by copper pontons. One of these bridges was at Tolhuys, and the other at Aonheim. The copper pontons were extensively used in his time and in that of his successor. Grébeauval replaced them by wooden *bateaux*. In the year 1746 Captain Guillet cast three bridges over the Po, measuring more than five hundred yards, in less than eight hours. They were burned immediately after the passage of the French army. Since that time a multitude of similar instances have occurred.

In order to decide on the means of passing a river with troops, the commander should have a thorough and detailed knowledge of the river; and it is the business of his staff officers — more particularly that of the engineers — to collect and furnish this information to him. For this purpose a careful reconnoissance of the river should be made, as well as all knowledge possible to be obtained from maps, books, the inhabitants of the country, and all other sources. Data should be obtained concerning the source of the river, its general direction, bends, and mouth; also the number and nature of the tributaries, and where they enter; whether it is navigable, by what, and how far; whether it *is* navigated; the number and kind of boats and vessels; what shoals and reefs there are, and

what whirlpools and gulfs; what parts, if any, pass through the enemy's territory.

Rocks and reefs, the presence of which is indicated by a disturbance of the water, are places very dangerous to boats; while the whirls or gulfs are cavities into which the water is precipitated, whirling and sinking below the general level. These last are also extremely dangerous to navigation.

The velocity of the water is not the same in the whole breadth of the river, but it is greatest in the *current*, where the water is deepest. The current is indicated by a rise in the height of the water. In some instances this rise is as much as three feet.

To determine the velocity of the current, we throw in some light body which will float, and note the number of seconds it is in passing the length of a base measured on the shore; this distance divided by the number of seconds gives the velocity. When the current is too far from the shore, anchor two boats in it at a known distance and proceed as before. Or we may use a log, as on shipboard; for this purpose throw in the log, attached to a fine, strong string which will freely run off a reel, and observe the time in which a certain distance is unreeled. A *very slight current* is about half a yard per second; an ordinary current, eighty-five hundredths of a yard; a *rapid current*, one and a half to two and a quarter yards; a *very rapid current*, two and a half to three and a half yards; and beyond that an *irresistible torrent*.

The straighter the bank the swifter will be the current. As the current is different at different times, we ought to know what it is at the highest, the lowest, and mean water, and what is the difference of level at those stages, and when these ordinarily occur. Note the influence of

the tides, and how far up they extend; also the direction of the winds, which are likely to bank up the waters. Learn if there are any bars, locks, dikes, or levees, and their object, and whether their destruction would produce a flood or a ford. With reference to overflows and high waters from the melting of snows, we must remember that the first occur in March or April, and the later and generally the larger in June and July. Freshets are indicated by an increase of current which disturbs the water at the bottom of the river; it is said then to run on the bottom.

Sometimes steady winds blowing up the river for a long time bank up the waters, arresting the progress of the current, and causing such a rise as to bring about serious accidents.

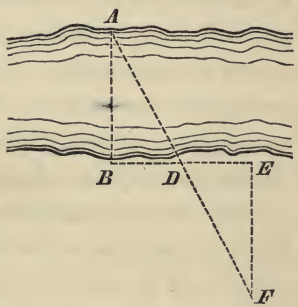
Learn at what times the river is frozen, and the thickness of the ice. The breaking up of the ice sometimes causes terrible freshets, because the sunken ice accumulates and dams up the river.

The swifter the current is the greater the size of the bodies which it carries; mountain torrents roll along quite large bowlders. In a flat country, deposits of very fine sand indicate a feeble current. Thus by inspecting the deposits in the bed of a stream, we can judge somewhat of the nature of the current. Learn whether the bottom is rocky, pebbly, or of sharp stones, which would interfere with the fording by horses and vehicles; whether it is of gravel, mud, or shifting sands; also whether it is covered with reeds and rushes which would interfere with the motion of boats.

Everything which arrests the flow of water favors the deposit of the earthy particles which it contains. In this way the resistance to the current offered by the sea gives rise to the bars at the mouth of rivers and harbors; and so, likewise, with the bars at the mouth of tributaries.

See whether there are any islands, their number, size, location; whether wooded or not, facilities for attack, and defence, etc.

The *width of rivers* may be determined by stretching across them a small cord or wire which is graduated.



If this method be not practicable, the width may be found, though not so accurately, by calculation: thus, suppose it is required to find the width of the river, *A B*; draw and measure, on the shore where you are, the line *B D E*, of any convenient length, perpendicular to *A B*; measure *E F* perpendicular to *B E*, also of a convenient length, and observe the point *D*, where the line *F D A* cuts *B E*; measure *D E* and *D B*; then we have from the similar triangles *A B D* and *D E F* the proportion *D E* : *E F* : : *D B* : *A B*.

The form of the bottom of the river may be determined by sounding with a graduated rod, at fixed distances from the river banks. Also the rise and fall of the water may be observed by driving pickets into the bottom a short distance from the shore.

Observe whether the banks are steep, and whether they are within range-points favorable to attack or defence.

These, and many other data which will suggest themselves to an intelligent officer, should be collected.

Rivers may be passed by fords, on ice, on floating bodies, or on bridges. Perfect order should characterize the different operations. Care should be taken to slope down the banks at the point of passage, so as to make an easy grade for animals and vehicles.

Passage by Swimming. — Swimming should be taught to all the troops, and swimming of horses to cavalry. This is much attended to in some of the European services, but in this country it is almost wholly neglected. Cavalry can pass a river by swimming better than infantry, because the horses swim naturally. To swim a horse, the rider ought, to a great extent, to let him have his own way; sitting quietly and directing him obliquely down stream, so that the current may not take too much hold upon him.

When it is necessary to turn the horse, the rein of the bridle on the side to which he is to turn should be taken carefully in the hand and his head slowly turned.

In the passage of the Rhine narrated by Boileau, all of the river, except about one hundred yards, was fordable. Some individual horsemen attempted to swim this part, and were drowned; but afterwards an attempt to swim a squadron-front at a time being made, and the men mutually sustaining each other, it was entirely successful; and in this manner the whole cavalry passed and defeated the enemy.

Horses are frequently discharged from on board ship by being thrust into the water, where they will follow to the shore other horses swimming and being led by persons in boats.

Passage on Ice. — This is an exceedingly precarious mode of passing a river. After a corps has succeeded in passing, a sudden change of temperature may break up the ice and cut off its communications. Besides this, great care and prudence are requisite in the operation to prevent frightful accidents. Ice which is from three inches to three and a half inches thick will serve for infantry marching by single file; when four and a half inches thick, cavalry and light artillery may pass; when four and six tenths to five inches thick, heavy *field* batteries can cross. The wheels should be fastened on slides, parallel to the axis of the carriage (not to the axles or axle-trees). A kind of sled will thus be formed; the horses must be taken out and led over, and then the pieces and carriages can be pushed across by the men. The ice should always be resting on the water, otherwise it is very insecure. The strength of ice may be much increased in very cold weather, by covering it with a layer of straw or of fascines, and pouring water over it to freeze.

To prevent accidents, straw or planks should be placed under the horses' feet and under the wheels; the carriages should not follow each other at a less interval than twenty paces; cannon of large caliber are slid over on sleds if the ice will not bear them when mounted on their carriages. In the winter of 1794 – 5 the French army, by means of ice passages, effected the conquest of Holland; and their *light cavalry captured a fleet of ships!*

Fords. — In a campaign fords are extremely convenient for the passage of rivers, not merely by small detachments,

but by entire armies. In the celebrated Italian campaign of 1797 the French army crossed the Tagliamento, in order of battle, and attacked and defeated the Austrians.

History, even the most recent, is full of examples. The best fords are those with firm, solid bottoms. In mountainous regions the fords are beset with large stones, which render them impracticable for wheeled carriages; in flat countries there is often mud or fine sand at the bottom, which is cut up by the horses' feet, thus destroying the fords. In torrent-like rivers, and those subject to freshets, the fords are changeable in depth and position, presenting but little security.

The ordinary depth of a ford should not be greater than three feet for infantry, four feet for cavalry, and two feet four inches for artillery. However, where the current is gentle, infantry can take a ford four feet deep.

It sometimes happens that a river is fordable all except a narrow channel, either because the enemy has dug it out, or that it is naturally deeper there than elsewhere. This channel may be all, or nearly all, filled up by sinking in it fascines with stones on them, or boxes or gabions filled with stones and gravel. It may be remarked, that if it should be found necessary to leave a narrow channel, it may be bridged over.

The location of fords may be found from the inhabitants of the neighborhood, or by observing where the tracks of vehicles enter the water; by the increased velocity of the current, or the increased width of the river; by a double change of direction within a short distance, — and in this

case the ford runs diagonally from one bank to the other. Also fords are sometimes just above a bridge, or at the mouths of streams and rivers.

A very good way of discovering a ford is to descend the stream in a boat or canoe, with a lead-line suspended in the water, having the proper depth for infantry or cavalry, as the case may require; on the cord should be a float, which would make its appearance when the lead touched bottom. When bottom is touched, the party sounding halt and sound in all directions for a ford, and mark out its direction and width by two lines of pickets driven into the bottom.

The lower line of pickets may have a line stretching from one picket to another, throughout its length, for the safety of those who may lose their foothold in crossing, and be in danger of being borne off by the current. This last precaution is very good for night passages.

Fords may also be formed by sounding with rods or poles; this is said to be the fashion of the Cossacks. They spread themselves along the shore, lance in hand, and as soon as one has found a ford they all join him, and in a very short time determine its width and direction.

When the location of a ford is known, before adventuring into it, swimmers should be sent into it to explore its nature and condition, to remove obstacles, and to repair it should the enemy have injured it.

They must fill up all *trous-de-loups*, or holes, which he may have dug there, either with fascines weighted down, or with stones and gravel.

When the water is very swift, a line should be stretched

along the upper side of the crossing, with empty kegs at intervals to float it. To this line, small cords are tied at frequent intervals, with blocks of light wood fastened at their lower ends to keep them floating. These will serve for those who lose their footing to seize hold on.

The Passage. — The infantry pass first; they should be in platoons, nearly at full distance. Next comes the artillery; and last, the cavalry. This order is observed, because the feet of the horses cut up and injure the ford.

The infantry soldiers should advance the up-stream shoulders, and carry their muskets on that shoulder; and to prevent wetting their ammunition, the cartridge-box should be fastened on top the knapsack.

The men must be careful not to gaze steadily at the water, because of its making their heads swim, as it is called; they should look at the bank. It is sometimes a good expedient to station a line of cavalry along the upper edge of the ford, to break the force of the current; and others along the lower side to catch those who are borne away by it. Sometimes (as in very cold weather) foot-soldiers mount behind the cavaliers, and so pass over. Finally the passage must be controlled by the particular circumstances of the case, and a sound discretion.

When cavalry are fording, the bridle-reins should be held somewhat tight, in order to raise the heads of the horses and compel them to look at the shore; for they, too, are troubled by the sight of the flowing waters. Neither should they be allowed to drink, for the same reason.

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A ford should never be attempted when the water is rising, unless it is certain that the whole force can get across before the ford ceases to be practicable. Moreover, no ford should be relied on as a sure means of communication, for it may be destroyed by a sudden freshet or other accident.

When *on a retreat,* fords should be destroyed behind us, by digging channels, holes, placing obstacles, sowing crow's-feet, etc. Crow's-feet are four iron spikes joined in one point, and pointing in different directions; so that when three are resting on the ground, one will be pointing upwards. Trees trimmed as for *abattis* may be fixed in the way, and any obstacles presented by the locality may be utilized for stopping or delaying the enemy. Finally, cut the banks into steep bluffs.

Passage by Boats. — Passage of rivers may be made in this way either in presence of the enemy, or by surprise, for the purpose of protecting the establishment of a bridge; besides, isolated corps, unless too large, may pass in this manner.

In the last case, it has the merit of despatch when compared with the time necessary to lay a bridge and take it up again.

When we have no *boats of equipage,* pontoniers and boatmen, escorted by light cavalry, proceed to seize all the boats to be found on the river, and take them to the point of passage; these men must be provided with the necessary ropes and tools. Their movements must be rapid and skillfully concealed.

It frequently happens that the enemy has destroyed or sunk the boats along his shore, and it becomes necessary to raise the sunken ones. In order to raise a sunken boat, we bring alongside of it two others, with an interval greater than its width between them; they should be fastened together by two beams extending across the gunwales, and solidly fastened. The boats are fast anchored, to hold them in place; then a line is run under one end of the sunken boat, fastened to an end of one of the auxiliary boats, and the men haul on the other end of the line. When the end of the boat is raised above the surface of the water, the line is fastened, and a similar operation is performed under the other end. When the boat has been raised, it should be bailed out and set afloat.

Another method would be to pass lines under the sunken boat, then let water into the two auxiliary boats until they are pretty nearly submerged, fasten the lines, and bail out the boats. On rising, they will lift the sunken boat; repeat the operation, if necessary, until it can be bailed out and taken possession of.

Sometimes a sunken boat can be dragged to a shallow place where it can be bailed. Auger-holes or ball-holes may be filled by conic plugs; leaks and cracks by tow steeped in tallow and covered over with strips of plank nailed on from the interior.

When the boats are all assembled at the crossing-place, if there is time, their respective capacities should be marked upon them. The steadiness of boats increases with their size. Their power of flotation is obtained by sub-

tracting their weight from that of the volume of water which they would displace if they were sunk flush with the surface of the water.

A rule used in the French military service is the following: Measure the height of the gunwales above the water, the boat being afloat; calculate the area of the horizontal section half-way between the water-line and the top of the gunwale; multiply together these quantities *expressed in metres*, and the product will give the number of cubic metres of capacity above the water-line. Now, since the cubic metre of water weighs 1,000 kilograms, you have the weight the boat can carry. Suppose the cubic contents were 8.75 cubic metres, the capacity would be 8,750 kilograms, or 19,250 pounds. The kilogram equals 2.204737 pounds avoirdupois, and the metre 39.37 inches. If the measures were taken in feet, multiply the number of cubic feet of volume by $62\frac{1}{2}$ pounds. But it would never do to load a boat down to the extent mentioned; hence we must cut down this estimate considerably. Measuring by the pace and the eye would then suffice.

The lower down the center of gravity is, the steadier will the boat ride. The following data will suffice to regulate the loading of the boats. A man under arms will weigh about 175 pounds; without arms, 140 pounds; and he will occupy a little over one third of a square yard. A horse will weigh from 900 pounds to 1,000 pounds, and will occupy about 9×3 feet. Six persons without arms can be placed on a space but little larger than a square yard, which gives a weight of near 900 pounds to the square yard.

The boats having had their capacities marked on them, they are drawn up according thereto, and crews are assigned in the proportion of one pilot to four oarsmen. The boats are propelled either by oars or poles.

Where there is no rudder, a fifth oar may supply its place.

Upon its arrival, the body of troops is divided into platoons, each chief of platoon being informed what boat is assigned to him, and when he is to embark.

The soldiers should neither embark in nor leave the boat in a body, for fear of upsetting it. Infantry should enter at the bow, and seat themselves upon or at the foot of the gunwales, beginning at the stern, the cartridge-box drawn around to the front, and the musket between the knees. If the water is too shallow near the bank, before entering, the boat should be shoved off a sufficient distance, and the men can wade into it. This remark also applies to landing.

While in the boat the men must remain perfectly still and silent, and they should be cautioned that, if the boat should lean over to one side, not to throw themselves too suddenly towards the opposite, especially if the careening should arise from running on some obstacle in the water; for there would be danger of upsetting.

A strict surveillance should be kept on boatmen who are strangers, both to see that they perform their duties well, and also to prevent treachery. Even those who were friendly have been known to jump overboard to escape the dangers of landing. In the immediate presence of the enemy the men should have their pieces loaded and bayonets fixed; but they should be forbidden, under the severest penalties, to fire without orders. When it can be done in shallow boats, the men should sit on the bottom, thus lowering the center of gravity and rendering the ferriage more secure.

A boat with 25 infantry-men should cross a stream 125 yards wide in a minute and a half. The efficiency of small boats can be increased by lashing together two, four, or more. Four boats arranged in this way could carry 80 per cent more than when used alone. This expedient was put in practice at the siege of Antwerp in 1832.

With small boats, cavalry are passed by putting six troopers in a boat, who lead their horses, swimming three on a side; unless the current is very swift, when only three horses will be taken at a time, they swimming on the lower side.

But when there are boats large enough, it is better to cross the horses in them. For this purpose a floor should be laid on beams upon the bottom, for the horses to stand on. The horses should be placed across the boat, head and tail alternating, their riders standing near their heads and holding the reins close to the bit. It is dangerous to place them lengthwise in the boat. A ramp or inclined plane is made in the bow to facilitate the getting in and out of the animals.

Artillery is transported dismounted; sometimes it is placed on two or more boats lashed together. This last method is to be preferred, because it enables us to take the pieces over mounted on their carriages.

In transporting materials and stores, the heaviest should be placed in the bottom. Those articles liable to injury from wetting, like powder, rations, and arms, must be kept out of the water, and covered with tarpaulins.

Navigation. — When, in place of crossing, it is intended

to navigate some distance along the river, in addition to observing all the precautions indicated above, the load should be diminished about twenty-five per cent, and the convoy should be preceded by a skiff or canoe, to reconnoiter and explore.

A river which has a fall of one in four thousand is of easy navigation, and may be ascended by sail; but a fall of one in two thousand is too swift for sail alone, and towage must be resorted to. Rivers with a fall of one in fifteen hundred are impracticable. Where the passages are very dangerous, local pilots must be procured.

A celebrated passage was made on the 25th of September, 1799, by the French army of the Danube before Dictiken. The boats which had been collected on the Aar and the Reuss, not being able to reach the point of passage without passing under the fire of the enemy, they were taken over a portage by wagon and by hand. The head of the convoy arrived at night at Dictiken; the boats were taken to the shore and arranged in order; it took one hundred men to carry some of the largest, while twenty men were sufficient for the smaller ones.

The boats all being in place and provided with their outfits, the boatmen lay down each behind his own boat, oar in hand. The smallest and lightest boats formed the right division, which was to lead the assault; those of medium size formed the left wing, whose duty was to carry an island occupied by the Russians, and whence they had a reverse fire on the point of passage. The heaviest boats formed the center. The artillery, commanded by General

Foy, had taken up a position to effectually protect the passage. Such was the silence and good order that reigned throughout this operation, that neither the Russians nor even the French troops themselves heard a sound. At a signal given by General Gasan, the banks of the river were covered with troops, who assaulted and beat the enemy, despite a heavy fire of grape. Another instance of boat passage under the fire of the enemy was that at Queenstown, by the American troops. The landing of General Scott at Vera Cruz was a specimen of well-organized and thoroughly successful boat service, although no opposition was offered by the enemy. Many more instances could be adduced.

Rafts and Foot-Bridges. — Rafts may be used, instead of boats. They have the advantage of not being liable to be sunk by the fire of the enemy, but are troublesome to construct, and require time. They are composed of logs, trimmed and very roughly dressed, to be fastened together; and ordinarily rectangular in shape, being held together by cross-pieces pinned or spiked to the logs. To make the rafts of the same consistency throughout, the logs should be arranged with the butts and tops alternating. The power of flotation of rafts formed of light wood is in proportion to their volume. For example, if the wood weighed six tenths as much as water, each cubic yard would sustain about eight hundred pounds. When rafts are long in the water they become water-logged, and lose their serviceableness. Rafts may be made of empty casks, fastened under light beams, which are covered with branches of trees.

In loading rafts the troops must go upon them in good

order and carefully. If a great number should rush upon them at once, they would infallibly capsize them. Infantry, marching by the flank, should first come upon the raft and occupy the middle of the whole length. Then two more bodies should come on simultaneously, the one going in front, the other in rear of those already established; and so on, until the load is complete. The men should hold their muskets resting on their feet.

Similar precautions are taken with cavalry; the horses are placed crosswise the raft, head and tail alternating. In loading with artillery, place the heaviest pieces in the middle, and distribute the remainder evenly over the raft, according to weight.

Navigation by rafts is advantageous where the bottoms of the rivers are rocky and uneven, but they are slow, require to be started in much farther above the landing, and drift much more than boats; besides, it is difficult with them to make the exact landing.

One of the most memorable passages on rafts was that made in 1701, across the Dwina. The king of Sweden sent across the first troops in boats, and these were followed by one hundred rafts, which had been prepared by General Dalberg; the Swedes carried the works of the Saxons, and forced them to retreat.

Foot-Bridges. — Small streams may be crossed by foot logs or bridges, caused by felling trees across. Where they are somewhat wider, cut a tree on each bank, opposite to each other. Retain the butts ashore, and let the tops swing around from above, lowering them away by lines, so

that the tops shall meet in the stream, interlacing and forming a salient angle up stream. Fasten them together, and remove whatever would impede the passage.

In this country, where every one knows something of frontier life, there would always be found among the troops many whose experience and knowledge of such things would suffice to take advantage of the particular circumstances of each case.

CHAPTER V.

MILITARY BRIDGES IN GENERAL.

IN the last chapter we discussed the passage of rivers by swimming, on the ice, on rafts, by boats, and by fords. But no means of passing rivers is so reliable for armies as that by bridges, and such is the usual method. Military bridges are those thrown across a river temporarily, for the passage of troops. They are, of course, much inferior in stability to permanent bridges, and they exact much care for their preservation.

As hinted before, this idea is by no means modern; but military bridges were in familiar use in very remote ages. The bridge over the Hellespont, constructed by order of Xerxes, is an instance; and it is a matter of curious interest to observe how closely it resembled a modern ponton-bridge.

Herodotus says: "A bridge was there constructed by a different set of architects, who performed it in the following manner; they connected together ships of different kinds; some long vessels of fifty oars, others three-banked galleys, to the number of three hundred and sixty on the side towards the Euxine Sea, and three hundred and thirteen on that of the Hellespont. The former of these were placed

transversely, but the latter, to diminish the strain upon the cables, in the direction of the current.

"When these vessels were firmly connected together, they were secured on each side by anchors of great length: on the upper side, because of the winds which set in from the Euxine; on the lower, toward the Ægean Sea, on account of the south and southeast winds. They left, however, openings in those places sufficient to afford a passage for light vessels, which might have occasion to sail into the Euxine or from it; having performed this, they extended cables from the shore, stretching them upon large capstans of wood; for this purpose they did not employ a number of separate cables, but united four of *biblos* with two of white flax. These were alike in thickness and apparently so in goodness; but those of flax were, in proportion, much the more solid, weighing not less than a talent to every cubit.

"When the pass was thus secured, they sawed out rafters of wood, making their length equal to the space required for the bridge; they laid them in order across upon the extended cables, and then bound them fast together. They next brought unwrought wood, which they placed very regularly upon the rafters; over all they threw earth, which they raised to a proper height; and finished all by a fence on each side, that the horses and other beasts of burden might not be terrified by looking down upon the sea."

When we get through with our account of ponton-bridges, it will be seen that we have not improved so much as some might suppose on the engineers of the time of Xerxes.

A military bridge consists, in general, of a platform about twelve to fourteen feet wide, made of strong planks, and is without parapets or fences, as Herodotus calls them. This platform or roadway rests upon small beams, which are supported by boats, rafts, or trestles. The portion of the bridge comprised between two consecutive supports is called *a bay*, and the two at the ends are called *abutment-bays*. The bridges are named after the kind of supports; as *ponton-bridges, trestle-bridges, raft-bridges,* etc.

The depth and velocity of the water, and the materials at our disposal, will determine the kinds of supports to be used; but it may often happen that we shall use several different kinds of support in the same bridge.

This kind of bridge being very frail, a prudent general would not trust to a single one only, because an accident to it might arrest the march of the troops at any moment, and compromise the safety of those who were already across, and thus cut off. The strategic choice of locality was indicated in the preceding chapter. In addition to what was there said, some other conditions must be combined, when practicable. Steep and high banks should be avoided, because otherwise we should be compelled to dig long ramps, or inclined planes, at the abutments. These ramps should not be steeper than one upon six; and it is desirable that the banks should not be more than six or seven feet high. We should avoid placing the bridge below a tributary held by the enemy, lest he should send down floating bodies to injure or destroy it.

Where the water is so shallow that the boats would rest

on the bottom, and be in danger of being crushed by the superincumbent load, they should be replaced by trestles. The axis, or middle line, of the bridge should be as nearly straight as possible, and the supports, of whatever kind, should have their lengths in the direction of the current, which otherwise would have too heavy a bearing upon them, and a tendency to overturn them. If the supports of the bridge are floating bodies, they should have such dimensions that the weight of the volume of the water displaced should exceed the weight of a bay of the bridge, increased by the greatest weight which is destined to be upon it at any one time.

Bridges of Boats. — These are constructed either with the boats of the army equipage or with the boats of the country.

Boats of Equipage. — These are a part of the equipage of the army, and move with it. Their details differ in different countries, while their essential features are the same in all.

That of the United States service — and which is a modification of the French — is as follows, taken from the Manual for Engineer Troops, by General Duane: —

34 *ponton-wagons,* each loaded as follows: 7 long balks; 1 ponton, inside of which are placed 12 balk lashings; 7 rack lashings; 7 rack sticks; 6 rowlocks; 2 spring lines; 5 oars; 2 boat-hooks; under the rear axle is lashed one anchor.

22 *chess-wagons;* load of each, 41 chess and 2 cables.

4 *trestle-wagons;* load of each: 2 trestle-caps, 4 legs, 4 shoes, 4 chains, and 14 short or claw balks.

4 *abutment-wagons;* load of each: 2 abutment sills, 1 trestle-cap, 2 legs, 2 shoes, 2 chains, 14 short balks.

4 *tool-wagons;* loaded with carpenter's and intrenching tools, spare cordage, etc.

2 *traveling-forges.*

Being 70 wagons, carrying 12 complete trestles, and 238 long and 118 short balks (beams or joists), 8 abutment-sills, 200 rowlocks, 192 oars, 100 boat-hooks, 70 scoops, 5 pumps, 10 buckets, 24 pickets, 240 rack sticks, 48 rack collars, cordage, 44 cables, 128 spring lines, 728 balk lashings, 360 side-rail lashings, 2 sheer lines, 6 sets of large double blocks, and 6 sets small double blocks.

If the equipage does not travel with the army, it should have a strong escort. In dry weather the pontons should be frequently wetted.

Before proceeding to construct a ponton-bridge, the materials should be assorted and arranged near the first abutment of the bridge. The pontons are launched *below* it. The construction begins with that of the first "bay." To this end, the ground is cut down, or raised, as the case may require, to the height of the boats. A beam with its upper surface on this level is then imbedded perpendicular to the direction of the bridge, and held in place by pickets driven into the ground. A ponton is then placed in position either 10 or 20 feet (according to circumstances), from the beam or sill on the bank, and securely moored with its length perpendicular to the bridge's axis. Balks are now placed with one end on the mud-sill, and the other just passing beyond the outer gunwale of the ponton, the balks being lashed to the gunwales. On top of these balks are laid the *chess,* or planks, which form the roadway.

Another boat or ponton is anchored 20 feet from the last, and balks are laid from the first boat to the second, lashing the ends to the gunwales and also to the ends of the balk first laid. On these balks are laid chess as before, and then the side-rails are lashed down on the ends of the chess at the sides of the bridge, to hold the planks in place. Proceeding in this way, a bridge is speedily laid across the entire width of the river. Generally every alternate ponton is anchored up-stream, and every fourth one down-stream. The distance of the anchors from the boats should be ten times the depth of the water; otherwise, when a strain is brought to bear upon them, the anchors will trip. Spring-lines, or guy-ropes, should be run from the ponton near the banks to fastenings on shore.

If the stream is narrow, say seventy-five yards wide, strong cables may be stretched from shore to shore, and fastened as taut as possible. The pontons may be fastened to these at the proper intervals by short lines, thus obviating the use of anchors.

The details of these operations have been organized into a regular drill, the men being divided into suitable detachments, the files numbered, and to each file specific duties assigned. The effect of this is to cause the work to advance without confusion and with immense speed. 120 pontoniers ought to construct a bridge from 100 yards to 110 yards long in about one hour.

These *pontons of equipage* are wooden boats 31 feet long and 6 feet wide. Besides these there are smaller ones covered with canvas, which go to form bridges for advanced-guards and light-cavalry expeditions.

These pontons are composed of two side-frames, 21 feet long by 2 feet 4 inches deep; they are connected by movable transoms. The pieces are of 4-inch scantlings of strong but light pine. The ponton is set up by placing the side-frames parallel, putting the transoms in place, and lashing them. The canvas cover is then drawn over the frame and lashed fast; the canvas should be painted black.

The canvas ponton-train is the kind used in the Russian military service. This ponton with its cover complete weighs 720 pounds, and has a flotation of 13,428 pounds. The weight of the flooring, etc., of one bay is 1,476 pounds.

If there should be a probability of the enemy sending down floating bodies with a design to destroy the bridges, certain sections should be so constructed that they may be promptly detached, making passageways or *draws* through which the floating bodies may be allowed to pass; after which the detached sections may be replaced. The number of these draws must be proportioned to the probable number of floating bodies to be sent down.

If the river has tributaries flowing from our side sufficiently large, it may be found convenient to construct in them portions, or even the whole, of the bridge, and to float it down to the place of crossing; in this way most of the work could be done without hindrance from the enemy. Thus after the battle of Essleng a bridge was constructed under shelter of Alexander Island, and at the proper time floated down; and in a few minutes put into position across to left fork of the Danube.

Bridges on Country Boats. — Inasmuch as these boats

will be of different sizes and shapes, some adjustments will become necessary. Those of the same size should be arranged together, to prevent sudden changes of level, or steps, in the roadway, and the long and narrow ones ought to be placed in the current; whereas those upon which the current would take a great hold should be in the still water.

If any of the boats should be found too weak, they can be strengthened by fastening cross-pieces on them; and on these cross-pieces should be fastened three string-pieces, one over the axis of the boat, and the other two parallel and near the gunwales. These pieces will receive the balks of the bridge. When a boat is found to be too low, a trestle may be securely fastened in it, and of sufficient height to come up to the level of the balks. The balk, or beams, may be secured by lashing, by spikes, or by cramping-irons. If anchors are wanting, the boats may be moored to fixed points, to rocks, to sunken mill-stones, to boxes filled with stone, etc.

A justly celebrated bridge was that made by Napoleon in 1809 by main force across the Danube. With but slender resources, the French troops constructed, over the three channels of the Danube, bridges near 1,000 yards in extent, and in the presence of an enemy 160,000 strong!

Bridges on Rafts of Logs. — These bridges have the great advantage of not being liable to be sunk by the enemy's fire, and the disadvantage of taking a long time to be built, of requiring a great deal of timber, of presenting a large

surface to the action of the current, and of being unwieldy and difficult to place in position. They should never be placed in positions where the current flows more than two yards per second.

The lightest woods, such as willow, fir, poplar, cottonwood, birch, and those woods of which the specific gravity is considerably less than that of water, should be chosen. The stability of rafts is greater as they are more oblong in shape: hence long logs should be chosen; and when they cannot be had of sufficient length, two may be spliced together. Those ordinarily used for rafts are 35 to 45 feet long, and about 1 foot in diameter; their number is determined by the specific gravity of the wood, the volume of the logs, and the weight to be borne.

The volume may be determined approximately by the following formula: $V = 0.785\ L\ D^2$; in which V is the volume, L the length of the log, and D the diameter at the middle; or $V = L\ C^2 .\ 0.0795$, in which C is the girth or circumference at the middle point.

To FIND THE POWER OF FLOTATION. — Weigh a cubic foot of the wood, subtract this weight from $62\frac{1}{2}$ pounds, and the remainder is the flotation of a cubic foot.

Knowing, then, the flotation of a single log, and also the weight of the bridge-timbers of one bay, as well as the greatest weight that will ever be on it at any one time, we can easily calculate the number of logs to be in each raft.

The result of this calculation, however, should be increased by two or three logs, to make up for the loss of buoyancy by imbibing water or becoming soaked. This can be pretty well remedied by painting or tarring the ends

of the logs. Before this is done the up-stream ends should be cut whistle-shape, or like the bow of a scow, to present less resistance to the water. For the same reason the plan of the upper end of the raft should be a salient angle, and the lower end a re-entrant angle. The logs should be neatly trimmed before being thrown into the water for building; they are then assembled in the rafts, butts and tops alternating, and are fastened together by three or four cross-pieces spiked or pinned to the logs. These cross-pieces are scantlings or saplings, and they should have a good bearing on the logs, the tops of which are flattened or countersunk for that purpose. On top of the cross-pieces others running lengthwise are placed, to receive the balks of the roadway, which should be elevated enough to clear the waves and to allow ordinary floating bodies to pass under. If *draws* are necessary, they must be made of boats, as being more easy to take out and replace.

In 1796 the French army, having no bridge equipage, constructed one of rafts across the Adige, near Roveredo, which had a draw of two boats near the middle. That bridge was 125 yards long; the rafts were 48 feet long by 16 wide. Being well made, it lasted a long time, and was taken and retaken several times by the Austrians and French.

Bridges on Rafts of Casks, Boxes, and Skins. — These bridges will only suit on small streams far from the enemy, because they are easily destroyed. A framework is prepared, rectangular in plan, having four longitudinal pieces 25 feet long, connected by four cross-pieces from 6 to 9 feet in

length. Two of the long pieces are near to either edge of the raft, being placed apart a little more than the bung diameter of the casks, which are placed under and in this rectangular space, end to end, with their bungs up, so that when they leak hand-pumps may be inserted to pump them out. In this position they are lashed fast, and make a raft of great buoyancy. A similar raft may be made of boxes which have been calked and painted to make them water-tight.

The rafts thus formed of casks or boxes will be placed at proper intervals for bridge-supports, and the roadway will then be built upon them as has been explained for rafts of logs. In some countries, — as Spain, Italy, and Southern France, — a multitude of wine-bags, or bottles formed out of cattle-skins, are found. These, when made air-tight and inflated with air, make bridge-supports suitable for light bridges.

Trestle-Bridges. — This kind of bridge is suitable over shallow streams with firm bottoms. The water ought not to be over 9 feet deep, and the current not swifter than 5 feet per second. Such bridges have the advantage of not requiring much material for their construction, which material can be brought from the neighboring forests and houses. These trestles are a large kind of carpenter's horses, made of light wood so as to be easily handled.

They are placed in the water at intervals of 12 to 15 feet, with their lengths in the direction of the current. On these trestles are laid the balks which support the roadway. They are also of admirable utility in constructing

bridges over deep ravines, where wagons might be stalled and the march of an army delayed. In a country the topographical features of which are like those of California, where these gulches are common, this would be of high importance.

Should the bottom of a stream be boggy, the feet of the trestles would sink into it; this can be obviated by a suitable shoe fastened to them, or mud-sills secured beneath.

Where the water is not too deep, the men can wade in to place the trestles; but when the depth of the stream forbids, the bridge will have to advance from one shore, being successively built from its front end.

Two long beams moving on a roller can be used. Place the trestles on their front ends, and roll forward until the trestle has come over its place, and then lower it into its position with ropes. Or else two skids may be used, reaching down to the plow of the next trestle, which is slided down the skids to place, and set upon its legs by hauling in on ropes and pushing out with long poles. Upon the trestles when in position are laid the balks, overlapping about a yard, and they are securely lashed to the trestles and to each other. If a draw is necessary, it must be of boats.

The crossing of the Beresina, in November, 1812, on the disastrous retreat of Napoleon's grand army out of Russia, was made by two trestle-bridges about 200 yards apart, and being about 100 yards long. The trestles were from 3 feet to 9 feet in height, and their cap-pieces were 14 feet long.

They were constructed with lumber obtained by demolishing houses in the village of Wesselowo, and were placed about 14 feet apart. In place of balks they used saplings about 5 inches in diameter, and they used saplings for flooring of one of the bridges. The other had a plank floor, the planks being taken from the houses of the village. These bridges would have amply sufficed for the passage of the whole army, had good order been maintained; but all discipline being lost, vast crowds poured upon the bridges, and produced disasters unexampled in history. The pontoniers, although worn out by a forced march, constructed these bridges in the space of twenty-four hours; they were compelled to swim amid the ice to place and repair the trestles, and their generous devotion cost most of them their lives.

Preservation of Bridges. — To defend a bridge from floating bodies, launched by the enemy or drifting on the current, the following means are employed: —

1. A lookout guard is stationed on the river, about 1,000 yards above, and this guard is provided with skiffs, long lines, anchors, grapnels, cramping-irons or staples, with mallets to drive them, boat-hooks, etc.

These boats, stationed at intervals one above the other, are rowed to any floating body that comes along; one end of a line is fastened to it, and the other sent ashore or fastened to a fixed point. The floating bodies are either towed ashore or swung round on to the shore by the action of the current. If some of the floating bodies elude these precautions, they should be steered towards the *draws* in the

bridge, and the sentinel on the bridge signaled to open the draws.

2. A floating stockade or boom is sometimes stretched diagonally across the river, so as to prevent the descent of the floating bodies, and run them ashore. A boom is a long chain of large logs, floating in the water with their ends fastened together by short chains; each log ought to be anchored. The angle made by the boom with the current should be about 22°, which requires its length to be $2\frac{3}{4}$ the width of the river. The boom is laid thus oblique so as not to receive a square shock from the floating bodies, and to direct them ashore.

3. The ends of the bridge should be movable, so as to adjust to sudden rising or falling of the water.

Passage of Bridges. — Military bridges being liable to many accidents, there ought to be as many of them as possible. It is dangerous to risk everything upon only one; the slightest accident might compromise the troops who have already passed. The unstable nature of these communications requires the utmost precaution. A sentinel should be stationed at each end of the bridge, and others along it at such intervals that they can see and hear everything that transpires, and carry out and enforce the following regulations: —

Infantry should march by the flank without beat of drum and in silence, being careful *not* to preserve the lock-step while on the bridge, because it would set the bridge to oscillating back and forth, and injure it seriously.

If this motion should start, the troops should halt, and remain standing until it subsides.

Cavalry should dismount, and each man lead his horse with a short rein, and prevent his trotting.

Care must be taken not to overload the bridge; fresh troops not being allowed to come on before those already crossing shall have completed the passage.

Such interval should be kept between the different bodies, that there will be no stopping and crowding at the end of the bridge. *Carriages* in single file and twenty paces apart should march along the middle line of the bridge; all drivers except those on the wheel-horses dismounted and leading. If any of the carriages should be too heavily loaded, a part of the load may be taken off; if one should break down on the roadway, the team should be promptly unhitched, the load stored in the nearest boats, and the carriage thrown overboard.

Infantry should never be mingled with artillery or cavalry in crossing at the same time. The troops should instantly obey the command "Halt!" given by a sentinel, and resume the march only when commanded to do so. If there should be several bridges, one should be exclusively for infantry, and another for cavalry or carriages. If there is a ford, also, the cavalry should cross there in preference.

Should there be a herd of beef cattle along with the army, they should be crossed in lots, or five or six at a time. It being the nature of these animals to huddle together in a crowd when frightened, if there were too many together they would ruin the bridge. Besides, as they nat-

urally swim well, they should be got across by swimming when practicable. No fires, not even lighted pipes or cigars, should be allowed on the bridge, for fear of burning it, or of explosions.

The sentinels must keep a sharp lookout for signals from above, reporting them or anything else of unusual nature to the officer of the bridge. They either halt troops or accelerate their march as circumstances may demand.

On ponton-bridges, infantry march in two ranks, or even three if the bays are not more than fifteen feet apart, cavalry in one rank, and the heavier field-pieces should be drawn by only four horses.

A detachment should be detailed to tighten the cords, to tend the draws, to raise the anchors now and then lest they become too deeply imbedded, and to make all the little repairs that may be requisite. If the bridge is likely to be frozen up, care must be taken to have it dismantled and removed in time, lest when the thaw comes it should be carried away. And if the bridge is destined to remain, the ice must be broken around the supports every day.

Flying-Bridges. — By this term we designate a boat, a draw, or a raft, held by a hawser or chain, which prevents it descending the river, and which is caused to go from one bank to the other by being held by a rudder oblique to the current. Flying-bridges have the advantage of being easy to construct, but they do not afford a continuous communication, and can serve but a small body of

troops. Experience has shown that the length of the cable should be one and a half to two times the width of the river. The cable is kept above the water by floats, such as casks, or boats, at suitable intervals. Thirty-six men can in an hour construct a flying-bridge on six boats of equipage, which would carry over two hundred and fifty men, or two pieces of artillery with twelve horses. This bridge would cross a stream of two hundred yards' width in a minute and a half.

We will close this chapter by a few hints as to the repair and destruction of bridges. In general, bridges are repaired by the same means which were employed in their construction. Bridges upon piles are frequently made in the rear of an army to keep open communication when it is necessary to take up our ponton-bridges and send them forward with the army.

Nothing need be said of the repair or construction of pile-bridges, for that operation is going on about the wharves of our cities all the time. When a masonry-bridge has been cut by the enemy, we can make a temporary wooden bridge over the gap. If the cut is too wide for our beams to reach, intermediate supports may be made by piles, trestles, or boats.

Destruction of Bridges. — If we are compelled to abandon a bridge, it should be sunk, burnt, or blown up. It may be burnt by putting straw, tarred fascines, or dry sticks underneath several places and setting fire at once. If there is not time for this, a large fire should be built in the roadway, taking up planks and piling on. This would detain

the enemy some time. Bridges may be blown up by fastening barrels of powder or loaded shells under the roadway, and firing them by slow-match or portfires.

Bridges may be sunk by knocking holes in the boats, at the same time cutting the lines and throwing the plank overboard. Masonry-bridges are blown up with powder; several arches ought to be blown up at once, to make the repair more difficult. When greatly pressed for time, several hundred-pound barrels should be suspended beneath an arch, and fired simultaneously.

Destruction of the Enemy's Bridges. — This is an operation of the highest importance, especially when we are resisting an attack which he makes by main force. If we can succeed in destroying his bridge after a portion of his troops have crossed, we will thereby cut him in two, and the result should be a brilliant victory in our favor. Different means are employed for the destruction of the enemy's bridges: 1st. Rafts and boats heavily loaded should be sent down the current against the bridge, to destroy it by the shock; these floating bodies should have in front a strong mast, well stayed, and of a height sufficient to encounter the bridge and strike it with violence. 2d. Use may be made of fire-boats loaded with incendiary materials and well supplied with shells and hand-grenades which explode from time to time, and intimidate any who might wish to approach the fire-boat. 3d. Infernal-machines, destined to destroy the bridge by their explosion, may be brought into service. They consist of boats provided with strong chambers of frame-work or iron filled with

powder, and weighted down by heavy bodies to increase the force of the explosion.

Fire is communicated by a pistol or musket, the muzzle of which opens into the powder, the hammer being cocked and the trigger connected with a lever, which when it touches the bridge will draw the trigger and explode the charge. Barrels and boxes filled with powder, and these or other arrangements for explosion, ought to be sent down in great numbers, and particularly in the night, so that some will surely escape the guard and arrive at the bridge. They should be so ballasted as to keep the right side up.

CHAPTER VI.

FIELD FORTIFICATION.

IN military language any construction or device which renders a position to be held by troops stronger than it was left by nature is called a **Fortification.**

The proper construction of fortification is called the *art of fortification;* and this art is divided into two great branches, which are termed respectively *Field-Fortification* and *Permanent Fortification.* These terms of themselves immediately suggest the principal difference between the two kinds of constructions; for while permanent fortifications are made at such places as are of enduring importance, like seaports and cities, and are constructed of the most lasting materials in an elaborate manner, field-fortifications are constructed hastily of earth, with the addition of wood and such other materials as are furnished by the locality, and are intended only to subserve the purposes of a campaign.

We will here confine our attention solely to the latter.

Suppose two bodies of troops equal in numbers, courage, discipline, skill, and equipment to meet each other in hostile array upon an open plain. The circumstances are equal; but if one of these bodies were posted on a hillside it would

possess an evident advantage over its opponents, who would be compelled to climb the hill to reach it. The party on the hill would have called into their aid the force of gravity, — no inconsiderable force, — and the assailants would be under both a moral and physical disadvantage.

If, moreover, the party on the hill had selected a position where there was a ravine or ditch at the foot of the hill, it is easy to see that their position would be yet stronger. Again, should they withdraw behind the crest of the hill, to such a distance that, while they could still see and fire upon their enemy as he was struggling across the creek or ditch and was climbing the hillside, and yet have their persons — save their heads and shoulders — screened from the missiles of the enemy by the crest of the hill, it is evident that they would possess a third great advantage over their assailants.

In these simple considerations can be discovered the principal feature of a fortification. To make a fortification we must make the hillside, the sheltering crest, and the obstructive ditch, where none previously existed. One of the simplest instances of a fortification would be had by digging a trench or ditch in front of a straight line of battle, throwing the dirt on the side *from the enemy*, and out of it forming an embankment or breast-height, behind which our own troops could stand, and over which they would fire upon the approaching enemy.

I have supposed a case in which the contending forces were equal in all respects. But fortifications are resorted to most generally by the weaker, when in presence of a

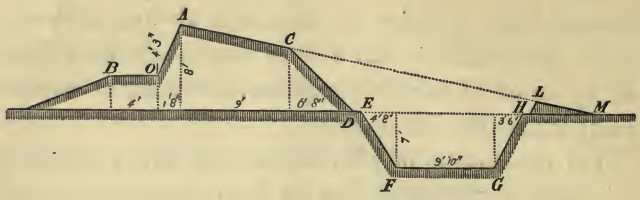
stronger force, — weaker, be it noted, in absolute efficiency, for it often happens that a force numerically the greater is, by reason of inferior equipment, discipline, or *morale*, really weaker than its opponent.

The ground-plan of a fortification may have a multitude of shapes, according to varying circumstances of locality and design in view; but the cross-section of the works, or profile as it is generally called, is essentially the same in all, consisting of the embankment, or *parapet*, and the ditch.

When defensive works are thrown up very hastily, and are intended merely to receive battle in, they are constructed by digging a slighter ditch, and the dirt is thrown on the *side towards the enemy*. The troops in this case stand in the ditch, and derive their shelter partly from the ditch and partly from the dirt thrown up on its bank. This kind of intrenchment received, during the late civil war in the United States, the name of **rifle-pits**, but that term was previously applied, especially by the Allies at the siege of Sebastopol, to small round excavations dug by single riflemen, or bodies of two or three riflemen, who crept forward during the night and made their lodgements, ready to open on the enemy at daybreak. These pitmen were sharpshooters to pick off officers, cannoneers, etc.

But the usual case is where the parapet is on the side of the ditch *from the enemy*.

The following is a representation of the profile of a parapet and ditch. *F G*, the bottom of the ditch, is nine feet ten inches wide; while the top *E H* is eighteen feet. It is



PROFILE OF PARAPET AND DITCH.

seven feet deep; the *interior crest A* is eight feet above the *terre-plein,* or natural surface; the *exterior crest C* is five feet six inches above the same. *B O* is the *banquette tread,* four feet wide, and at a perpendicular distance below the interior crest of four feet three inches. The banquette slope is the ramp falling from *B* rearwards to the terre-plein. The banquette-slope and tread are made only when the parapet is too high for a man standing on the natural surface to shoot over. *O A* is the *interior slope; A C,* the *superior slope,* and *C D* is the *exterior slope; D E* is the *berm; E F* is the *scarp,* and *G H* is the *counter-scarp.*

By prolonging the line of the superior slope *A C,* it will be observed that a ball from a musket lying on that line would strike the ground beyond the ditch at *M,* and consequently all the space within the angle *H M L* would be *dead space,* or not attainable by missiles fired from the works. To remedy this, another embankment having the gentle inclination of the superior slope is made upon the counter-scarp bank of the ditch, which has the effect of exposing the entire person of the enemy as he approaches. This embankment in front of the ditch is called the *glacis.*

Plan. — When the enemy has no choice but to approach

directly from the front, a straight parapet and ditch will make a good defence; but this could be improved by flanks running forward from the right and left of the line so as to bring a cross-fire on the enemy as he approached.

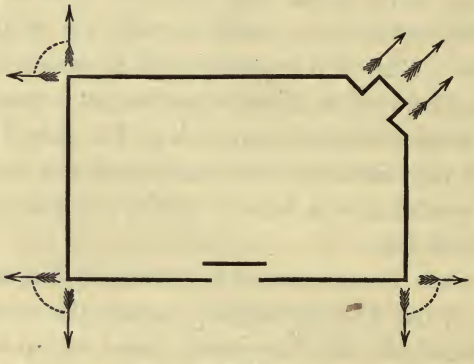
But the enemy certainly will not approach directly from the front if he can avoid it, but will if possible march around the flanks of our work and come upon us in the rear. This operation is called *turning* the work, and neutralizes or destroys its utility. If he cannot succeed in turning the work he will at least endeavor to come upon it in a slanting direction, that is, with his line of march making a very small angle with the direction of the parapet; in which case very little of our fire could be brought to bear upon him.

This would be true even of the musketry-fire, but still more so of that from the artillery, because the pieces with which field-fortifications are usually armed are too small to fire in *barbette* (i. e. over the top of the parapet), but are fired through notches or troughs cut down in the parapet, which are named *embrasures*.

As these embrasures necessarily allow only a limited *field of fire*, or sweep to the right and left for the cannon, they cannot be brought to bear upon a column of troops advancing in a slanting direction. To avoid the inconvenience here spoken of, deflections are made in the direction of the parapet to produce flanking arrangements that will give cross-fires, of which more will be said anon.

It is only in a few localities, such as narrow gorges, ravines, and streets, that the enemy would be compelled to

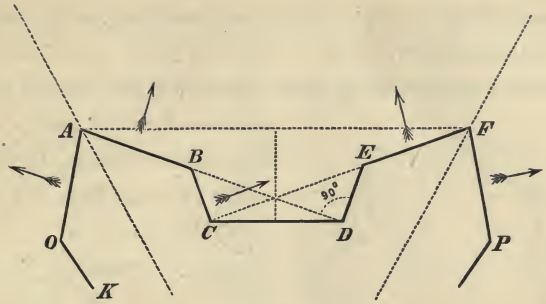
approach from the front. The general case is that he can turn a line of works, especially if it is a short one. To secure ourselves against this disaster, it is a natural expedient to fortify in all directions, thus inclosing the position to be fortified. A plan which would naturally suggest itself would be a square or a parallelogram.



REDOUBT.

But upon inspecting such a plan it will be seen that if the assailant approaches along the prolongations of the diagonals, in other words, marches upon the corners, he would be exposed to a feeble fire. The angles included between the arrow-heads are called **Sectors-without-fire.**

To get rid of these sectors-without-fire we must resort to what are called **Flanked Dispositions.** In these, certain portions of the work are thrown forward towards the enemy and are called **Advanced Parts,** while others are held back and are called retired parts. Such a disposition is shown in the following diagram.



Wherein *O A B* and *E F P* are the advanced parts, and *B C D E* are the retired parts, *O A* and *A B* are the *faces*, as are also *E F* and *F P*; *B C* and *D E* are the *flanks*, and *C D* is the *curtain*. *A D* and *C F* are the *lines of defence*; *O A B* and *E F P* are the *salient angles*; *B C D* and *E C D* are *re-entering angles*, and *A D E* and *F C B* are *angles of defence*.

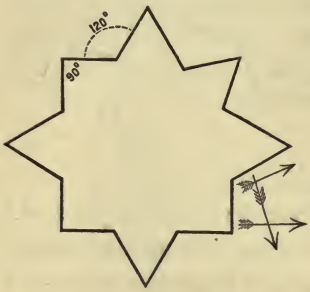
It will be seen that the angle between the arrow-heads at *F* is swept by a fire from the flank *B C*, and also from a flank perpendicular to *F P* prolonged, and which is not shown in the figure. And so of the other sectors-without-fire.

The *faces* may vary in length from thirty to eighty yards, the *flanks* from twenty to forty yards; and the curtain should never be less than twelve times the *relief*, which is the height of the interior crest above the bottom of the ditch.

The kind of a front which we have just described is called a **Bastioned Front.** The bastion front is the best for an *inclosed* fort, because not only are the sectors-without-

fire remedied, but the ditches are thoroughly swept by the fire of the garrison.

In the square redoubt before spoken of the sectors-without-fire may be pretty well remedied by making what are called **Pan-coupées,** the corners being cut off, and replaced by shoulders, the fire from which will be in the directions of the diagonals; but still the ditches are dead spaces, in which the enemy, once arrived there, is comparatively secure.

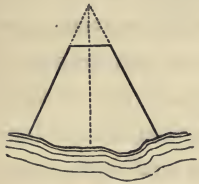


Besides these are *star forts,* which give something of a flanking arrangement, as may be seen in the figure above.

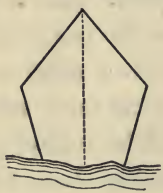
Not only may flanking dispositions be used for isolated positions, but also to connect and secure the different parts of long lines which are used to strengthen extended positions.

If we have a position where the flanks are secure from being turned, by reason of precipices, impassable mountains, water or morasses, it may be fortified by a **Cremaillêre** or **Indented Line.**

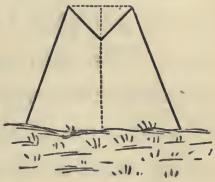
Should the position be assailable not only in front but on the flanks, while the rear is secure, there are various other dispositions which can be used, according to locality



REDAN.



LUNETTE.



PRIEST-CAP.

and other circumstances. We may mention the **Redan,** the **Lunette,** and the **Priest-cap,** or **Swallow-tail.**

Long lines may be secured and connected redans, lunettes, and cremailleres, or any combination of them which may be found expedient. There are continuous lines, and lines with intervals. The first have no openings through which the enemy might penetrate, except a few for the convenience of the defenders, and these are usually covered and concealed from view by small redans in front of them.

The second kind are marked by detached forts, which are separated by wide intervals, the intervening spaces being defended only by cross-fires from the forts. The **Redan Line** is a series of redans connected by curtains, — the faces of the redans about 60 yards long and the curtains about 180 yards. In this arrangement the ditches are not flanked, or swept by our fire; this defect is remedied by changing the curtains from long straight lines to broken ones, constituting new redans, with their faces perpendicular to those of the original redans. This is called the **Tenaille Line.**

A great variety of combinations of lines has been used by different engineers, but it would not profit to enter into an examination of them here.

Tête-de-Pont. — A tête-de-pont, or bridge-head, is a detached fort placed near the end of a bridge to secure the same. Its plan may be a redan with a pan-coupée, a lunette, priest-cap, or any form suitable to the locality. If practicable, it should be supported by the fire of batteries placed on the opposite shore, which shall cross in its front, and sweep along its flanks.

Revetments. — When the slopes of any of the embankments of fortifications are not steeper than the natural slope of the earth, they will stand and do very good service, with no other preparation than packing and ramming; but to prevent the effect of rains, it is well, when there is time, to cover the surface of the slope with sods of grass.

These sods should be cut from a sward where the grass is short and has thickly matted roots; they should be evenly cut in rectangles, and laid like the tiles of a pavement. But this precaution, which is optional on gentle slopes, is necessary on steep ones, — like the interior slope of the parapet, the scarp and counter-scarp of the ditch.

Any facing made to sustain the face of a slope is called a *revetment*. It may be of sods, stone, or wood, and also of a mixture of clay and earth; these last materials are mixed with water into a stiff paste or mud, and laid on about a foot thick, being well packed.

Fascines. — A fascine is a cylindrical bundle of rods or twigs, bound together or wrapped with *withes*. They are

from 9 to 12 inches in diameter, and from 10 to 20 feet long.

To make a revetment of fascines, say for the interior slope, the first layer is laid horizontally at the foot of the slope, being about half imbedded below the banquette-tread, and held in position by stakes driven into them, and also by having withes leading to anchoring-pickets driven into the interior of the parapet at intervals of a few feet. On top of this layer, as the parapet rises, is laid another layer of fascines fastened to the anchoring-pickets and to the fascines below, and so on to the top.

Hurdle Revetments. — A hurdle revetment is made by laying parallel poles along the face of the slope and in its direction, driving them into the earth at its foot, and then making a kind of wicker-work by interlacing twigs or withes with the poles. The poles are laid as if they had been driven in an upright row at the foot of the interior slope first, and then inclined over until they lay against that slope.

Gabions. — Gabions are sometimes used for a revetment. A gabion is a hollow cylinder of basket-work, made of twigs. They are set on top of each other, in the direction of the slope, and filled with earth.

A revetment is often made of scantling and planks.

Bags filled with sand are often used to form a revetment when great haste is necessary, and even to throw up a hasty shelter or parapet. But as the bags soon rot, they are only used for works of a very temporary character.

It may be well to say a word about **Powder-Magazines.**

Some place must be had, of course, for storing the ammunition. The requisites are that it be safe from fire, the enemy's shot, and dampness. If the site of the work is dry ground, they ought to be placed under ground, the sides and top being made of framed work, and planks or fascines. The vault may be about 6 feet wide, and of the same height, with length sufficient to hold the ammunition.

On the top of these should be a thickness of 6 feet of earth, and the entrance, which should be from the rear, should have a splinter-proof screen, to prevent fragments of the enemy's shells from entering it. Where the soil is very wet, the powder-magazines are sometimes placed in the traverses.

A **Traverse** is a short embankment, generally made with gabions, which run perpendicularly to the rear from the parapet. When traverses are used there are always several, and their object is to prevent the splinters of the enemy's shells from having an extended range up and down, or to the right and left, along the work. Usually two pieces of cannon are found between two traverses. The traverses extend to the rear only far enough to shelter the cannoniers.

Palisades are forts made of wooden logs set into the earth in an upright position to form walls. The logs are hewn flat on the sides which are in contact, and the garrison fire through loop-holes cut between the logs. There may be more than one tier of loop-holes; the men firing through the upper holes while standing on a staging constructed against the palisades, and upheld by a parallel row of posts about six feet to the rear.

Block-Houses are built of logs either upright or horizontal, and often of two thicknesses, the one upright and the other horizontal. They are provided with loop-holes, and are sometimes defended by a ditch with a draw-bridge. Being usually square or rectangular in plan, they have *sectors-without-fire.*

This can be remedied by having two stories, the upper story being turned around, or so placed that its walls shall be perpendicular to the diagonals of the lower story. With this arrangement the fire from the upper story will entirely remove the sectors-without-fire.

Obstacles. — It may be well to cast a passing glance at some of the devices which are classified under this heading. When the enemy is approaching the work to assault it, it is desirable to reach him at the earliest possible moment with our projectiles, and to detain him under fire as long as we can. With this view we cut down all trees within extreme range of the fort, level off banks and small hillocks behind which he could be concealed or protected, and make whatever arrangements are practicable to diminish the number of avenues of approach.

If the routes by which he can come upon the work are few, his men will be more massed together, and therefore more vulnerable, while we, being called to attend to but a few points, will be able to bring to bear a greater proportion of strength on him.

Among the obstacles designed to detain the enemy in front of the work are *chevaux-de-frise, trous-de-loups* or military pits, *crow's-feet, mines, abattis,* etc.

A **Cheval-de-frise** is a log or scantling bored through by augers, the alternate holes running through in directions perpendicular to each other. Through these staves or poles are passed up to their middle, having both ends shod with pike heads. *Crow's-feet* are composed of several sharp iron spikes, united at a single point, but all pointing outwards, so that when thickly scattered on the ground they form a serious obstacle to the march of troops.

Abattis are trees cut down and laid with their tops towards the enemy. Only the smaller branches are cut off, while the longer limbs have their ends sharpened and pointed towards the enemy. They are interlocked and tied together.

Trous-de-loups are pits dug in the ground to about the depth of six feet, and are five or six feet in diameter at top. They have a stake, sharpened at top, planted in the bottom.

Mines are deposits of gunpowder placed under the glacis, and connected with a hose or train leading under the parapet. They are intended to be exploded when the enemy arrives over them; and their moral effect is immense.

Attack and Defense. — An attack may be made openly or by surprise, but in either case it is necessary to obtain all the information possible about the work beforehand. Much valuable information may be obtained from spies and deserters, but this information should be received with all the circumspection recommended in a previous chapter.

Another method is by reconnoissance; that is, to go and see. An officer, attended by an escort sufficient to drive in

the pickets and outlying parties from the garrison, approaches and examines the defenses, endeavoring to observe the strength, equipment, and nature of the garrison, the nature of the work, the depth and width of the ditch, whether dry or filled with water, the number, caliber, and position of the cannon, the presence or absence of obstacles in front of the ditch, etc. If an attempt to surprise the post is to be made, it should be done at night, selecting the time about two hours before day, because then the sentinels are always less vigilant than earlier in the night, and besides, the garrison will be in a deep sleep.

The storming party will, of course, approach in the stealthiest manner, picking their way around or through obstacles. Engineer troops with tools should precede them, to remove obstacles. If the ditch is deeper than six feet, scaling-ladders should be taken along for the purpose of descending into the ditch and mounting the parapet on the other side. Sentinels must be secured or bayoneted.

There should always be several false attacks made along with the true one, to divert the attention of the garrison, confuse them, and divide their forces. The false attacks must be conducted by parties strong enough to convert them into true ones, should they meet with better success than they anticipated.

The leaders of the different parties should all know which is the true attack, so that, should they succeed in getting into the work, they may hasten to that point.

The storming parties should be of picked troops, especially of such as had volunteered upon that occasion.

When an open attack is made, all obstacles should be destroyed, as far as can be done by the fire of artillery.

A heavy fire should be concentrated on the enemy's guns until they are silenced. Shells should be fired into the parapet to cause the earth to slide down into the ditch, forming a ramp by which the parapet may be mounted. When the assault is about to be made, a cloud of light troops is thrown out to open a fire on the garrison, and divert their attention from the storming columns.

These last should advance over the intervening ground with the utmost celerity. The remainder of the troops follow close to repel sorties, and support the stormers, who will *not stop to fire,* but rely exclusively on speed and the bayonet.

Defense. — To make a successful defense there should be troops enough to allow of two ranks all along the banquette, and a suitable reserve beside. The defenses and equipments must be put into the most serviceable condition. When an attack is expected, the enemy must be closely watched by scouts and patrols, and lookouts must be stationed at those places behind which he could approach unperceived. Bodies of troops sufficient to repel and keep aloof all reconnoitering parties must be maintained on the outside. At night the number of sentinels must be increased, and after midnight unusual vigilance enjoined and enforced. In anticipation of an attack the different troops should have their duties assigned them, and they should be drilled therein. Occasionally, but not frequently, false alarms of an attack should be made,

to accustom the minds of the garrison to such an emergency.

The men, in case of a real attack, should be exposed as little as may be consistent with a good defense. For instance, while the enemy is cannonading the work previous to an assault, all the troops except the cannoneers and sentinels may lie down behind the parapets and traverses. The reserve should be kept sheltered until called into action.

When a night attack is expected with confidence, fireballs should be thrown out to light up the neighborhood of the enemy, and to disclose his movements.

Should the enemy's storming columns be shaken and thrown into confusion by the fire of the garrison and by the obstacles, a sortie should be made in force to complete their confusion and to put them to rout.

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CHAPTER VII.

STRATEGY.

IN this chapter only a few of the leading principles of strategy will be considered, the subject being one the discussion of which might be carried to almost any extent; vast tomes might be, and have been, written upon the subject, but it is deemed expedient here to spend but a little time in its examination, and we will confine ourselves to its leading features. This not because the subject is of but little importance, — far from that; but because it is in its nature less definite and fixed, less subject to specific rules than any branch of the art, and because it is impossible to give directions for all the cases which may arise.

Strategy is defined in Scott's Military Dictionary to be "the art of concerting a plan of campaign, combining a system of military operations determined by the end to be attained, the character of the enemy, the nature and resources of the country, and the means of attack and defense." It has also been defined to be "generalship, the science of military command, the science of conducting great military operations." Although it may be difficult to improve on these definitions, it is certain that they are somewhat vague.

In directing the movements of bodies of troops, there are three departments calling for consideration; to wit, *Tactics*, *Grand Tactics*, and *Strategy*. **Tactics** comprise those precise, formal, well-ascertained, and elementary movements of troops upon a small theater, which are prescribed in works on that subject. **Grand Tactics** have a more extended range, are the movements on a more extended scale, are less definite, not so clearly foreseen, and are not executed by uniform technical commands. Grand tactics also have their theater on the field of battle or in the immediate vicinity of the enemy. The adaptation of the different arms of service — infantry, cavalry, and artillery — to the different kinds of ground; the selection of the proper time for them to come into action; the disposition of brigades, divisions, or army corps; turning movements during a battle; the posting and ordering of reserves; feigned attacks, retreats, and ambuscades, — may be considered as belonging to the domain of grand tactics.

Strategy has a still more extended range, looks further into the future, and combines and directs the movements of large bodies of troops, and even armies over a greater scope of country; still, the limits of strategy and grand tactics are so commingled, that it is not always practicable to point out distinctly where the one ceases and the other begins. Many of the operations described in the chapter on moving of armies belong to the domain of grand tactics, and some were strategic.

Strategic points are such as are of great importance to us for securing our subsistence, insuring our safety, facili-

tating our success, or which may enable us to annoy, foil, or defeat the enemy. Of such are cross-roads, particularly in a timbered and broken country, where roads are of prime importance; places where railways meet, passes through mountains, fords across rivers and plains where navigation is interrupted by falls or rapids, large cities, fortified posts, the capital of a country, etc., etc.

There may be no strong reasons of a physical kind or reasons in themselves strictly military for making the capital of a country an object of great interest, and yet political and moral considerations may confer upon it great strategic importance.

The first things which should engage attention in the planning or conduct of a campaign should be the *Base of Operations*, the *Line of Operations*, and the *Objective Point.*

The Base of Operations may be a point, but is more generally *a line*, whence our army sallies forth to march upon the enemy, from which we draw our supplies and reinforcements, and upon which we expect to fall back in case of reverse or disaster. In case we invade the enemy's territory by land, it would naturally be the frontier of our own.

But if we are engaged in a defensive campaign, it would be a chain of fortified posts or cities, or a river, parallel to the frontier, and in which would be stored our reserves of men and materials, and behind which we could retreat in case of necessity.

The Line of Operations is the line or route along which we advance from the base, and it should be perpendicular to it.

The **Objective Point** is that point of the enemy's country which it is our object to strike, such as the point where his forces are stationed, the capital of his country, or the grand depot of his supplies.

These three things must be maturely considered, and settled upon with great circumspection and deliberation before we begin to act. We must form a distinct conception of what is to be done, whence to set out, how to go, and where to go. If we propose an invasion, it may be that the geography of our country offers but one frontier from which we can advance upon the enemy, and then this will necessarily be the base of operations. On the other hand, we may have a choice of several, and we would select that one from which we could *soonest* reach the objective point, and could at the same time most easily keep open our communications. If two lines of our frontiers meet in a salient angle penetrating the enemy's territory, it would be well to begin the demonstration by assembling on the apex so as to create doubt in the enemy's mind as to which was to be our base of operations.

If we should move from out a re-entrant angle, our flank would be secured during the earlier part of the march by the contiguity of portions of our base to the right and left; but, on the whole, it is probable that a straight line perpendicular to the line of operations is as good as any.

When once we move from the base we should advance with the utmost speed upon the objective point; for time, in war, is the most important of all things.

Under no consideration must we expose ourselves to

being cut off from the base; amid all the varying phases which may appear during the campaign, this injunction must be borne steadily in mind. Should there be indispensable passes, fords, or bridges to be left in our rear, they must be fortified and held in sufficient strength. We should remember that every inhabitant of the country may be a spy or a messenger for the enemy.

If the enemy is carelessly dispersed in cantonments or otherwise, it would be our policy to strike his center, and then, turning towards either wing, to beat his separate corps in detail. Thus being stronger than the enemy in any one combat, we should by acting with vigor and despatch be sure to crush in succession all his forces, and might terminate the campaign and the war at one blow.

Should we, however, find the enemy on the alert, with his troops well in hand, and occupying a strong defensive position, we may make a feint or a real attempt to cut his communication with his base, and thus inflict great loss upon him, or compel him to abandon his strong position. In this way we will attack him under more favorable circumstances, or, what may be found to be still more to be desired, compel him to attack us on ground of our choosing. But this movement is one of great hazard, because we must not sacrifice our own communications.

There may be, however, circumstances under which a general would not hesitate to abandon completely his own communications, and throw himself upon those of his enemy. If he knew the enemy's troops to be greatly inferior to his own in numbers, discipline, or spirit, or that

their general was wanting in decision, slothful or vacillating, and that the population was an unwarlike one, upon whom he could subsist without creating an insurrection, he would not hesitate to do so. It would be an additional inducement to make this hazardous move, if by so doing he could throw back the enemy upon some impassable barrier, such as the sea, a mountain range without passes, or an impassable river.

On the contrary, should the enemy's general be an able one, this attempt would almost certainly terminate in disaster; and if the population were warlike and accustomed to arms, seeing an invader in this position, which in general must be regarded as a false one, and stung to resistance by his exactions, they would rise in mass to the assistance of their own army and overwhelm him. It requires a great genius to see distinctly all the elements entering into such a problem, to balance them together and combine them so as to eliminate the real truth, and to be able to decide whether such an attempt is feasible or not. It is much easier to write about such things than to do them.

There is no rule in strategy which can be dogmatic and exact; any one will admit of great many exceptions.

There were never two campaigns or two battles exactly alike. A general should be perfectly versed in the rules and principles of strategy, and at the same time be provided with profound knowledge of men and things, and that sound and admirable discretion which would enable him to know when and how far to depart from those rules.

Thus it was recommended above that, when a general

found the enemy's troops scattered, he should throw himself between them; if he should find them scattered, but not sufficiently far apart, it would be the worst thing he could do. He must know when he attacks one fragment that he has time to beat it, and have his troops in hand again before succor can arrive. And here, by the way, is a distinction between grand tactics and strategy. To get between the enemy's divisions would in strategy be a most fortunate move, while as a matter of grand tactics it would almost surely result in ruin.

Should the invader be successful, no rules are necessary as to what should then be done. It will be easy enough to carry out ulterior operations. But the case is quite different if he meets with a reverse so serious as to require a retreat. The invader will then be in a position calling for the very highest qualities of a tactician, a strategist, and a man. As a general rule the lines of operations — now become the lines of retreat — should be *one*. To divide the army into different columns would be to expose them to be beaten and destroyed in detail with great facility. The army should be held in as compact a mass as possible, and it should pursue a single line of retreat towards the most available point of the base. It should be conducted with the utmost speed compatible with good order, but it must not be allowed to degenerate into a rout or a flight. All available means must be employed to deceive the enemy as to the line of retreat, to destroy every facility for, and to throw all possible obstacles in the way of, pursuit.

Where strong passes or defiles are found which are not

likely to be turned, it may be well to seize and hold them, and then to await his assault. This will serve to rest the army, give an opportunity to restore its organization, and, by beating off the enemy, the spirits of the men. Then, while the enemy is still in the confusion of his repulse, the retreat must be resumed. Often it will be best to effect this at night, some light cavalry being left behind to keep up the camp-fires, and to make, as far as may be, the usual appearance of things about camp until the retreating force has got a good start: then they will rejoin the main body.

Still, there may be occasions when it would be best to divide the force, and to pursue different and divergent lines of retreat. Should there be a strong probability of the different columns reaching the base in safety, it will be best to divide. The columns being smaller could move with increased speed; the pursuer would probably lose some time while hesitating which to pursue, and, at the worst, it might be that he could not overtake and destroy more than one fragment, and thus the others could be saved. Large bodies of light cavalry, such as the Cossacks, may retreat with great speed upon different points of a desert, continually scattering and disappearing into it, safe from pursuit. This is frequently done by our border Indians. The infantry of the Scottish Highlands have frequently escaped after this fashion into their mountain fastnesses.

The Defensive Plan. — A defensive war may be carried on by remaining near our own borders and a little within them. Thence we sally into the enemy's country upon favorable occasions; we have the advantage of short lines

of operations, being near our own base; in fact, the whole country will serve as a base to us. When the enemy enters our country, he will be continually weakened by detachments to hold the places he may take, to protect his convoys of supplies, and to keep open his communications. The population, being unfriendly, will act as spies on his movements, and will inflict loss by cutting off stragglers, patrollers, etc., etc.

The dispositions to be made in the *defensive* plan cannot be prescribed in a dogmatic manner. So many circumstances come up for consideration, — such as the nature of our own population, whether warlike or not; the nature of the enemy, whether able and enterprising or the opposite; the topography of the country, and a number of other circumstances which ought to have weight in the decision, — that none but the most general direction can be given.

It is useless to attempt to defend the whole frontier; it is not practicable, and the attempt weakens our force by dispersion, so that it will have little or no effect on the enemy, and becomes liable to destruction in detail.

It is best to seize and hold by a considerable force the points of penetration most favorable to the enemy, while the main body occupies a central position to the rear.

With the main body the advanced posts must keep up a constant communication by means of swift couriers, signalmen, and telegraph. The enemy must be kept under continual watch; and all his movements promptly reported to head-quarters. When he attacks any of the posts it must be stoutly defended to detain him there, until the main

body and other detachments can be concentrated upon him. For this purpose an ample supply of the means of quick transportation must be kept in hand, ready at a moment's warning; such as railway-cars, wagons, etc. Should he succeed in penetrating the frontier, it may be well to lure him into the interior, where he may be attacked at disadvantage. We should endeavor to fall upon his flanks while marching, or, still better, to cut his communications by getting in his rear.

Everything which could be of use to him must be removed or destroyed. If he can be defeated in such a position, there is every probability of his total ruin.

If this method of dealing with the enemy be not found practicable, we will know almost certainly what his lines of operations will be. Upon these we must have fortified and strengthened the narrow passes or other strong places not liable to be turned, where we will receive his attack, and will expect to convert his repulse into total ruin.

Should we be unsuccessful here, we must fall back, and concentrate on similar positions previously prepared, and so on in succession, rememberirg that it will never be too late to despair.

We will add but a few more remarks on this subject. The government should be extremely careful in selecting the general-in-chief; and when he is once selected, they should not hamper him with minute instructions, but leave him a wide latitude of discretion. Nor should they be in great haste to remove him upon the first misfortune. Misfortunes and defeats have happened to the greatest mas-

ters of war. Evidences of incapacity should be clearly perceived before a removal is resorted to. The fear of such a contingency may cramp the genius, and to a large extent incapacitate a really able general. Another thing to be borne in mind is, always to follow up a victory. How many great victories are recorded in history which have been without fruit from the supineness of the victors!

The army should be habituated to expect success, and to know that when the enemy is broken and driven from the field of battle their work has just begun.

When he is retiring in dismay and confusion, it will be ten times easier to break him up and annihilate him than to fight him another battle. Let the light cavalry and horse-artillery be launched upon his flanks and rear, incessantly pursuing and destroying. Let the remainder of the army follow as fast as may be; the animation of success and the certainty of more success and greater success ought to destroy fatigue; victors can afford to go hungry.

An endeavor has been made in this chapter to point out some of the leading ideas of strategy: there are several treatises on this subject; the elaborate one of Jomini being generally considered the best. The principles of strategy are not changeable; they are founded on human nature and the topographical features of the theater of war. These do not change. Tactics and even fortifications change with every new armament of the troops, but it is not so with strategy. Hence the best method of becoming acquainted with the subject is to closely study, assisted by good maps, the campaigns of the great masters,—Alexander, Hannibal, Cæsar, Napoleon, Wellington.

CHAPTER VIII.

THEORY OF FIRE AND TARGET PRACTICE.

NOTWITHSTANDING all the talk which we hear about bayonet charges, it has long been recognized to be a fact, that the principal effect of infantry is to be found in their fire. And this is still more certainly the truth since the universal introduction of *arms of precision*, and the greater amount of target practice which obtains in the instruction of soldiers. It is proposed here to investigate to some extent the principles on which firing is done; but beforehand to make some remarks upon the phenomena of the combustion of gunpowder in the barrel of a gun.

When powder is inflamed in the barrel, an elastic fluid is developed which escapes with violence from its confinement, and drives before it whatever is in its way. The velocity with which the ball is chased from the gun is the speed with which it moves. Velocity is space passed over in a unit of time. The *initial velocity* is that with which the projectile moves at the instant of leaving the gun.

Powder does not burn all at once, but progressively; the exterior grains burn first, and disengage a large volume of gas, which, moving with a high velocity, penetrates into the interstices of the remaining grains, setting them on fire,

and so on until all the grains are burned. In this way, at each successive instant more and more gas is developed, so that the ball, although it moves over the length of the gun-barrel in an extremely short time, yet acquires its velocity gradually, and attains its maximum velocity only when it has arrived at the muzzle of the bore.

Any degree of dampness is injurious to gunpowder, so that its effect is less in rainy than in dry weather.

The initial velocity of the projectile depends on the amount of the charge, the quality of the powder, the length of the bore, the size and density of the ball, and on the *windage*. The **Windage** is the amount of space between the sides of the bore and the surface of the ball; or, it is the space by which it fails to fill the bore.

For any given ball and given length of bore, there is a maximum velocity, beyond which it is useless to try to go. In smooth-bore cannon it is attained by a charge one third the weight of the ball. If there is no windage, as is the case in rifles, the experiments of different nations, though quite various in result, seem to indicate a charge about one tenth the weight of the modern balls. The longer the projectile is subjected to the accelerative force of the gas, the greater velocity will it require, which would indicate long barrels as the best; but there is a limit to this, arising from various causes. In smooth-bore arms, there is, on account of the windage, shocks and friction of the ball against the sides of the bore, which rapidly diminish the velocity, and place a limit to the length of the barrel, which for such pieces is about forty inches.

The more resistance the gas of exploded powder meets with the more force it develops; consequently the heavier the projectile is the greater the amount of motion it receives. A ball twice as heavy as another will receive more than half as much motion from the same charge. With a given charge small and light projectiles receive the highest velocity while *within the bore*, but as soon as they are out they rapidly lose it, because of their relative incapacity to overcome the resistance of the air.

Recoil. — There is no action without a corresponding reaction, and consequently we find that the greater the charge the more is the bottom of the bore driven back, and the action on the arm is greater than it is on the projectile, because the arm receives the whole of the reaction, while the projectile, on account of the windage, does not receive the whole of the action; besides, the gas continues to react on the piece, even after the ball has left the muzzle. The velocity thus impressed upon the gun is called the *recoil*.

With an initial velocity of 1,475 feet, the smooth-bore infantry musket would experience a recoil which, if it were expressed in velocities of the ball, would be 2,314 feet; that is to say, that the ball would have to be moving with a velocity of 2,314, in order that it might strike the musket and communicate to it the velocity which it really has when the ball leaves it with only a velocity of 1,475 feet.

But velocities are in the inverse ratio of the masses to be moved; and the musket spoken of weighs about 174 times as much as its ball, so that the backward velocity of the gun is $\frac{2314}{174} = 13.3$ feet. This velocity is sufficient to

hurt the shoulder, unless the gun is pressed tight against it, joining the mass of the man's body to that of the gun. Now if we suppose the effective weight of the body acting in this manner is ten times that of the gun, the velocity of recoil would be only 1.3 feet, which is easily bearable. Moreover, this does not take in to account the crook or angle in the stock of the piece, which mitigates very much the effect of the recoil, because the force being thus decomposed into two components, only one of them is expended against the shoulder; the other tending to rotate the gun upwards.

The ball leaves the gun so quick that the recoil has not much effect on the accuracy of the fire; still it has some, and in guns for very close target shooting we see very *heavy barrels;* their force of inertia being great enough to nearly or quite destroy all inaccuracy from the recoil.

When the ball is not down in contact with the powder, the gas, moving with a high velocity, is suddenly arrested by the ball, and there is every probability of the barrel being burst; and the farther the ball is from the charge, the greater the danger. Not only may such an accident arise from a ball above its proper position, but mud or frozen snow have been known to burst a gun in this way.

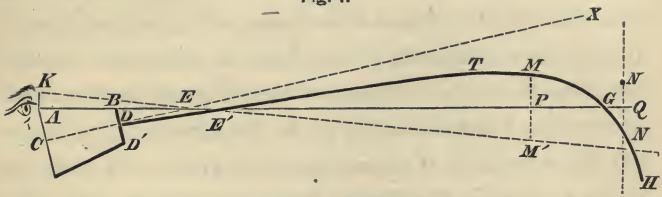
Heating of the Barrel. — This arises from rapid firing, and bright and polished barrels heat faster than others.

Experience demonstrates that a gun cannot be handled after it is heated to more than 165° or 170° Fahrenheit; and as gunpowder requires a heat of about 400° to explode

it, there can never be any danger from the heat of the barrel.

There are three lines necessary to be known in a fire-

Fig. I.



arm with their relative positions, to wit: —

The *line of sight,* the visual ray *A B E G* which passes along the top points of the breech and muzzle, and is directed upon the object to be struck; second, the axis or *line of fire,* which is the axis of the bore prolonged *C D X;* third, the *trajectory D E T G H,* described by the center of the ball in its flight. The projectile, being fired along the direction of the axis *C D X,* would follow that line if it were not drawn by the force of gravity; but under the influence of that force it is always below *D X.* If it did not encounter the resistance of the air, that is, were it fired *in vacuo,* the curve described would be a parabola; but the resistance of the atmosphere modifies the shape of the curve, and modifies it the more as the velocity is greater. The shape of a gun, large or small, is larger at the breech than at the muzzle, so that the line of sight makes an angle *B E D* with the axis, and cuts it at a short distance in the point *E.* The angle *B E D* is called the **Angle of Sight.**

As the lowering of the ball in the earliest moments of its

flight is but small, the trajectory cuts the line of sight in a point E' quite near to E, especially in small arms, passes above it, and afterwards in the descending branch cuts it a second time at G, which is named **the Point-Blank.** The axis, the line of sight, and the trajectory all lie in the same vertical plane, called *the plane of fire.* This is quite natural, for there can be no reason, in the ordinary condition of things, why the ball should go to the right rather than to the left, when it is of homogeneous material and symmetrical in shape. **The Range** is the distance to which the projectile goes; $B\,G$ is the *point-blank range.*

The **Angle of Fire** is the angle which the axis makes with the horizon, or a level line; on a level plain the range increases as the angle of fire increases up to a certain limit, which depends on the size and velocity of the projectile. This angle is called the *angle of greatest range,* and is never greater than 45°, which is the angle of greatest range of a projectile *in vacuo* when supposed to be moving with a low velocity. The angle of greatest range for a musket is from 25° to 35°.

There are several causes which would make the range vary from the point-blank range, the chief being, first, the velocity of the ball; second, its diameter and weight; third, the inclination of the line of sight; and, fourth, the shape of the barrel.

1. We have already remarked that the velocity depends on the charge, length of bore, etc.

2. The diameter and weight of the ball will produce changes in the range, because the larger and denser it is,

the better will it overcome the resistance of the air, the longer retain its velocity, and the more accurate be its flight compared with another ball having the same or even a greater velocity, but which is smaller and less dense.

3. The inclination of the line of sight will make a difference, but only when that inclination is considerable. When the gun is pointed upwards the force of gravity diminishes the velocity and brings the point-blank near; on the other hand, when it is pointed downwards, gravity helps the ball onward and produces the contrary effect. But for inclinations within 15° above and below the level, this effect amounts to but little.

4. The greater the difference between the diameters of the breech and muzzle, the greater will be the angle $BED = XEG$, and the greater the distance to the point-blank. On the other hand, the less the difference between those diameters, the nearer will the point-blank be brought. If this difference be continually diminished, the line of sight will finally become tangent to the trajectory, and there will be no point-blank; consequently, if the line of sight is parallel to the axis, there is no point-blank.

In the same model of arms the forms are the same, consequently the angle of sight remains the same; the charges are the same, and so are the balls; the habitual elevations and depressions are within $+15°$, so that we consider the points-blank and trajectories as practically invariable. It results from this that the line of sight and trajectory may be considered as having a constant relation to each other; and we would know the principles of fire if we knew the

positions of the different points of the trajectory with respect to the line of sight.

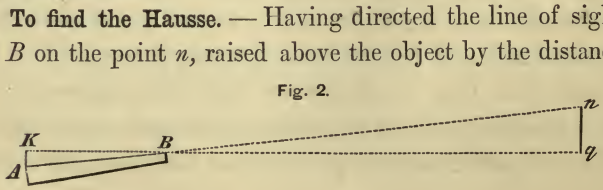
Figure 1 shows that, in order to strike an object at the point-blank, we must aim directly at it, that is at G; that to strike an object P this side of the point-blank, we must aim *under it* by the space $P\,M' = P\,M$, which is the rise of the trajectory above the object Q, and, on the other hand, if we wish to strike an object Q, *beyond* the point-blank, we must aim *above* by the space $N'\,Q = N\,Q$, the distance of the trajectory below the object. If we were to aim directly at Q, the ball would pass below it at N.

Now if we increase the angle of sight, the part of the trajectory $E\,T\,H$ lying above the new line of sight, $K\,H$, will be greater; the ball being fired under a greater angle will go farther, and the new point-blank H will be more remote than the former one G. The angle of sight may be augmented, and the diameter of the breech apparently increased by using a *hausse*, or hind-sight $A\,K$. (Fig. 2.)

This hausse enables us to look directly at the object instead of aiming above it, which will be, of course, more accurate and more convenient. These hausses are often seen on the breeches of muskets, or near them, and either turn on hinges or are arranged to slide up and down upon upright pieces.

To find the Hausse. — Having directed the line of sight $A\,B$ on the point n, raised above the object by the distance

Fig. 2.



$q\,n$, fix the arm in that position, then place a small stem or standard $A\,K$ on the bore of the breech, and sight along it from B to q, and mark the point K where the prolongation of $q\,B$ passes.

It will readily be understood that the use of the hausse has the effect of augmenting the angle of fire, for it lowers the breech and raises the muzzle which increases the angle of fire.

Construction of the Trajectory. — The line of the trajectory can be calculated from an equation which is approximately true, and then constructed, but it is better done by experiment.

Place on a line upon a level surface a number of screens made by stretching canvass upon frames and fire a number of shots, under the same condition as to aim, elevation, charge, etc., through them, and then find on each screen the mean position of the points struck or mean impact. These points of mean impact being connected, give the trajectory. One screen only may be used by placing it successively in the different positions. After firing on it at each position, the screen may be covered with paper or cloth pasted on it.

Causes of Deviation in the Projectile. — 1. The barrel. Want of accurate construction or any crookedness here will prevent the ball following the proper direction. Any change in the position of the sights will change the range or the direction. Thus if the hausse, or hind-sight, is too much to the right, the ball will go too much to the right; and the same for the left. 2. The windage. The ball

being loose in the bore will *ricochet* from one side to the other as it passes out, and consequently will not follow the axis. This is not so in the rifle. This bounding may take place in any direction, but it usually occurs in a vertical plane, modifying the angle of fire by several minutes of a degree.

Combined Effect of the Action of the Air, and of Imperfections in the Projectile. — When a body is thrown out into the air it takes up a motion of rotation, and the point about which it rotates is its *center of gravity*. The center of gravity is that point by which the body must be suspended in order to remain in whatever position is given to it. The rotation is around an axis passing through the center of gravity.

If there were no resistance of the air, the centre of gravity of the body would move as if the body were not turning; but the fact is quite otherwise, on account of the resistance which the air makes to a body moving with a high velocity.

This resistance, which when the round ball first leaves the gun is about 98 times its weight, causes so much greater effect as the motion is eccentric, that is, as the amount of air encountered is greater. In a ball of perfect sphericity and homogeneous material, the center of gravity and the center of figure coincide, and the only resistance is that of friction.

But as balls are not perfectly round and homogeneous, these two centers will be separate; now the force of the powder acting on the mass is applied to the center of grav-

ity, and the air acting on the surface is applied to the center of figure; hence will arise a motion of rotation of the center of figure around the center of gravity, the lighter part of the projectile around the heavier part; a motion which will be greater as the two centers are farther apart, and the resistance of the air greater.

The effect of the resultant of the resistance of the air would nearly always be to push the ball out of the plane of fire, for it would be an accident for it to happen to be directly in the path of the center of gravity.

The trajectory would thus become a curve of double curvature.

If the axis of rotation should be perpendicular to the plane of fire, and the center of gravity be in that plane, there would be no deviation. If the center of gravity should be in the plane of fire, and the heaviest part in front, there would be no rotation at all.

The motion of rotation just spoken of, in connection with those of the shocks in the barrel, gives rise to very irregular trajectories. The greater, then, the resistance of the air, the greater the deviation; and of balls of the same size, the lighter will be farthest driven from its path.

And it is to be remarked, that balls of the same material and less diameter will be deviated in a greater proportion. Thus a ball one half the diameter of the musket-ball would weigh $\frac{1}{8}$ as much; the resistance of the air due to its weight would be 92×8; but since the surface of the little ball is only $\frac{1}{4}$ that of the larger one, the resistance would be $\frac{98 \times 8}{4} = 98 \times 2$; double as much as that of the larger ball in proportion.

All things else then being equal, the largest, densest, and best shaped balls are those which are least driven from the natural path.

4. The temperature and degree of dampness of the air, and amount of dampness of the powder, will influence the range and trajectory.

5. The wind blowing across the path of the ball will cause it to deviate more or less, according to the strength of the wind. If it is a strong wind blowing directly across the trajectory, it has been found to deviate the ball about $\frac{1}{2}$ inch in 160 yards. It acts like an accelerative force, the deviation being proportional to the squares of the distances; thus at 320 yards the deviation would be $\frac{1}{2} \times 4 = 2$ inches. The wind may also throw a ball up or down as well as sidewise.

Inaccuracy may also arise from the unevenness of the ground over which we fire deceiving the sight.

When firing at a moving object it is necessary to aim at the point where we suppose the object will be when the ball has gone over the distance. For instance, a horseman crossing the line of sight at the distance of 160 yards at a gallop — say with a velocity of twenty-two feet per second — will advance eleven feet in half a second. The ball will arrive there in that time. The horse is about nine feet long, so we should aim about three to four and a half feet in front of his head.

Deviation from Unskillfulness of the Marksman. — The greatest cause of deviations are in the marksman himself. A soldier after having taken a good aim often destroys it

by a sudden jerk on the trigger. Soldiers should be taught to take aim with an empty gun, at first with a rest and then offhand. The visual ray must pass from the bottom of the notch of the hausse, or hind-sight, to the top of the front-sight, and thence to the object. If the eye is raised above the proper position, the gun will shoot too high. They should be practiced in snapping caps at a lighted candle, so as to learn to pull the trigger gradually, keeping the line of sight on the flame. If placed three and a half feet from the muzzle, it will be blown out by a correct aim. From this they should advance to firing blank cartridges, and afterwards firing ball cartridges, carefully at a target.

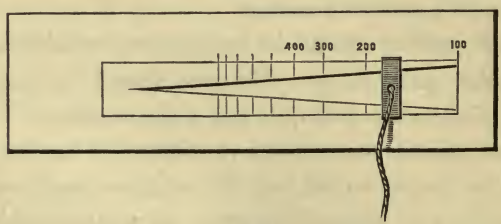
They should be taught to plant their feet firmly; the left foot thrown to the front, and the right foot at a distance of one pace to the right, and pointing in that direction. The sights must be exactly on top; should they be revolved over towards the right, the ball will go too much to the right; and the converse.

Target practice should be frequent and conducted with the utmost painstaking. The men should be taught to judge of distances promptly and with accuracy. To this end men should be stationed at different distances, which should be known to all, and the soldiers taught to note what features or parts of the dress are distinguishable by the eye at the different distances. Afterwards men should be stationed at unknown distances, and the troops practiced in guessing them; they should be subsequently measured.

Stadia. — This is a little instrument carried by the

officers and non-commissioned officers, which is used to determine distances. It is an oblong piece of brass out of which is cut an isosceles triangle, the base of which is much smaller than its altitude. The stadia when used is held at an uniform distance (the length of the arm) in front of the eye; the altitude of the triangle being horizontal.

It is graduated with a number of vertical lines, on which are marked certain numbers. These numbers are the distances in yards at which a constant object, like the height of a footman from top of cap to sole of foot, can just be seen through the triangular slit at those marks. On the other side it is graduated for a horseman. To keep it at a constant distance from the eye a string is attached with a knot at the loose end, which is placed between the teeth when the instrument is in use. The string is attached to a slide, which moves right and left over the triangular slit, and assists in taking sight.



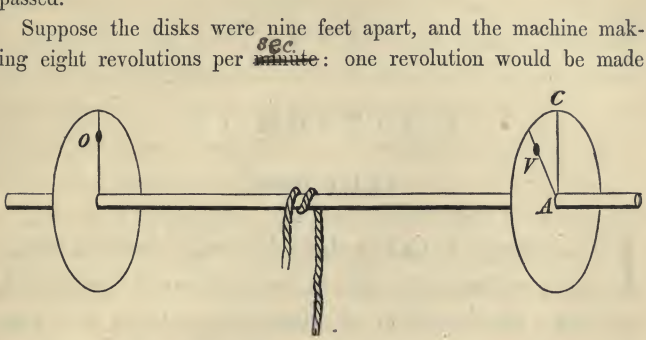
STADIA.

To calculate the initial Velocity. — Let two vertical disks of paper or cloth be placed at a known distance apart on a horizontal axis, and set to revolving uniformly with considerable velocity.

Place the muzzle of the gun close to one of the disks, being parallel to and immediately over the axis of the machine; fire the gun,

and note the position of the two points through which the ball passed.

Suppose the disks were nine feet apart, and the machine making eight revolutions per ~~minute~~ sec.: one revolution would be made



in $\frac{1''}{8} = 0''.125$. The ball first passed at O, which was then in a vertical line, and through the second disk at V, which by that time was on the vertical line. Measure the angle $V\,A\,C$: suppose it $= 30°$ $= \frac{1}{12}$ the whole circumference. Hence the wheels were revolving $\frac{0''.125}{12} = 0''.0104$, while the ball went nine feet.

If the ball goes nine feet in $\frac{104}{10000}$ of a second, how far will it go in $\frac{10000}{10000}$ or a whole second? $104 : 9 :: 10000 : x = \frac{90000}{104} = 865$ feet; and that was the initial velocity.

CHAPTER IX.

SMALL-ARMS.

IT is proposed to make a slight historical sketch of small-arms, commencing with a hasty glance at those which antedated the invention of gunpowder. It is not possible to find out what arms were first invented, nor when nor by whom.

The exigencies of men in the simplest form of savage life would demand weapons of some kind for the purposes of hunting, and for defense against wild beasts. Almost simultaneously wars would arise having their origin in the passions of men or the necessities of self-defense. Unable to cope successfully with those whom nature had endowed with superior strength, the weak would seek to supplement their deficient power by the artificial aid of weapons.

The first weapons undoubtedly were clubs and goads, or sharpened poles. As the stronger would still be the victors in this kind of strife, the weak would resort to fighting from a distance by hurling stones. At first, no doubt, this would be done by hand, and soon after by slings. Then would follow arrows shot from bows, giving an opportunity for skill to triumph over mere force.

The discovery of metals at a late date would induce the invention of lances, swords, helmets, and defensive armor for the body. We are told in the Book of Genesis that Abraham, when he went to the rescue of his kinsman Lot, "numbered of the servants born in his house three hundred and eighteen *well appointed* and pursued them (the enemy) to Dan."

It is very remarkable that we should find in the Bible so little distinct and valuable information on the subject of weapons, for the Israelites were a very warlike people, and they were almost continually engaged in war with their neighbors. These wars are recorded with their results; but almost nothing is given in detail of the nature of their arms.

Rome, Greece, Egypt, and Assyria have all left us satisfactory records on this subject in the way of descriptions, inscriptions, pictures, bas-reliefs, and specimens either handed down or dug out of ruins; but the case is different with Palestine. And yet we are far more familiar with the history of the Israelites than with that of any of their contemporaries.

Something, however, can be gleaned by minute attention to this subject. The earliest mention of the sword is in Genesis xxxiv. 25, where, in the account of the massacre of Shechem, it is stated that "Simeon and Levi took each man his *sword* and came upon the city boldly and slew all the males." Frequent mention is afterwards made of the sword, but we know nothing of its shape, weight, and mode of use. It was called a *chereb;*

and as David, who was not remarkably large and strong, was able to use with facility the chereb of the giant Goliath, we may infer that the ordinary sword was much less in proportion to a man than is the modern sword. We also infer that it was worn in a scabbard and slung from the waist by a belt, from the expressions, "*girding* on the sword," "men that *drew* the sword," etc.

There are different kinds of *spears* mentioned, the largest of which was the *chanith*. Of this sort was Goliath's, with its handle like a weaver's beam, and its iron head weighing 600 shekels, — about 25 pounds.

There was also the *cidon*, which is supposed to have corresponded with the javelin. A third kind was the *romach*, which was a spear in common use. Bows and arrows are mentioned in Genesis, while the earliest mention of slings is made in the Book of Judges, chapter xx. Occasional reference is made to breastplates, helmets, and shields. Battering-rams are mentioned in Ezekiel iv. 2, and elsewhere in the same book. These implements of war were well known to the Egyptians and Assyrians.

At a very early period cities were protected by walls, from which arrows and stones were fired upon the assailants, and from which chariots, armed with scythes, issued to carry, by the speed and strength of horses, dismay and havoc amid the ranks of the enemy. Soon came the use of cavalry acting by their shock, and elephants, on the backs of which were towers filled with archers; then cars carrying catapults and balistæ; and then cross-bows, mus-

kets, cannons, repeating rifles, mitrailleuses. Who can foresee the end of these mechanisms?

Courage and skill, strengthened by military discipline and a knowledge of the art of war, are potent elements of victory; but the effect due to the nature of the arms is incontestably great.

Thus the use of cuirasses at one time gave the preponderance to physical strength; but the invention of fire-arms removed this distinction. You will readily recall to memory the saying that "gunpowder makes all men equally tall." Even when both parties use the same arm, the difference of quality, shape, and method of use is of high importance. Witness the speedy and paralyzing defeat of the Sadowa campaign, due more than to any other cause to the difference between the Austrian rifle and the Prussian needle-gun. The greatest of generals have ever been solicitous to secure the best improved arms. The Romans, those great masters of the art of war, never hesitated to abandon their own arms or military devices, and to adopt those of their enemies, when they found them of superior quality.

Arms may be classified into those requiring for their use more than one man, or *artillery*, and those susceptible of being used by a single individual, or *small-arms*. Let us confine our attention, for the present, to the latter. Small-arms are of two kinds, — those with which we strike the enemy immediately and directly, such as the sword, the saber, and the lance or bayonet, and, secondly, *projective arms*, used for fighting at a distance. Of this

kind are the musket, rifle, and pistol in modern times, and among the ancients the bow, the sling, and the cross-bow.

The first class were those first in use. They were made of wood, having points and edges of bone or flint; afterwards they were manufactured out of copper and bronze, as these were metals more easily worked than iron. The precise epoch at which weapons of iron and steel were introduced among the Romans cannot be ascertained, but it is highly probable that the short Spanish sword which they adopted was of iron, tempered or converted into steel, inasmuch as iron ore abounded in Spain.

The arms of the ancients were pikes, swords, sabers, and axes. The pike, according to its dimensions, was called by different names. The *sarissa* of the Greeks was a pike from 16 to 26 feet long, and was borne by the infantry; the *lance*, which was neither so long nor so heavy, was the weapon of the cavalry; and the *hasta*, of medium proportions, was used by both kinds of troops. The *pilum* of the Romans was about seven feet long; it could be used as a pike, but ordinarily it was hurled against the enemy. The *javelin* was a half-pike, and served the same purpose as the Roman pilum. The Franks used an arm called the *angon*, which was a javelin, but the point had beards turned towards the rear, like those of a fish-hook, which when buried in the flesh or in a buckler was extremely difficult to be extracted. The *javelot* was a long and very sharp dart thrown by the hand. The lance carried by the knights of the Middle Ages was from 13 to 20 feet in

length, and had a heavy shoe on the end to make it more manageable.

Somewhat akin to the pike was the *sponton* and the *demi-sponton*, which was between 6½ and 7 feet long, and was in use during the times from Louis XIII. to Louis XV.; the *halberd* and *partizan*, which, beside the pike-head, had on each side a little ax, or an ax and a point, or two crotchets or hooks. They were in the hands of the officers of the foot troops only.

Swords and sabers were of various shapes and dimensions. The Roman sword was broad, short, and straight, being very suitable for thrusting; that of the Gauls was long, straight, and keen, but was liable to break during a combat. The *scimitar* is a heavy saber sharply curved towards the point. The *dagger* is a heavy poniard. The *ax* is a very ancient arm, and has had a variety of sizes and shapes. The Franks used a small ax or hatchet, called the francisk, which they threw at the enemy. Then came *battle-axes*, *marteaus* (a species of hammers), and *masses d'armes*, calculated for breaking and crushing armor.

Among *projective* arms the **Sling** is the most primitive. It is a sack, or bed of leather, sustained by two thongs, one larger than the other, and wrapped around the hand, the other retained under the thumb until the moment of projecting the stone which lies in the sack, when it is allowed to escape. By a rapid motion of rotation a strong centrifugal force is impressed upon the stone, which can be hurled more than 300 yards.

The inhabitants of the Balearic Islands formerly had a great reputation as slingers.

The **Bow,** likewise, goes back to a very high antiquity. The bow is usually made of the *yew-tree,* which is both tough and elastic, and varies in length from 5 to 8 feet for battle purposes, although it must be noted that the American Indians make use of much shorter bows, which are deadly at short range. It is not unusual for them to drive an arrow through the body of a buffalo, and the combination of rapidity of firing with accuracy of aim is superior to that of the revolver. But the quiver is soon exhausted.

In ancient times the Cretans were renowned as archers, and in times more recent the bow was the toy, the pride, and the triumph of England. According to the stories of certain authors, the man who could not put one dozen arrows into the target in one minute was no soldier at all. They report also that the arrows would pierce through a two-inch plank at a distance of 250 yards. Bows are sometimes made of steel, and, whether made of wood or metal, it is the elasticity of the material which gives the bow its power; and the larger, tougher, and heavier it is the more powerful the weapon becomes.

The **Arrow,** as is well known, is a long and slender stalk or shaft of wood, armed with a sharp head of steel, and having some feathers arranged on either side near the rear end. The sharp and long head of the arrow easily cleaves the atmosphere, and the feathers, meeting with more resistance from the air, are compelled to remain in

the rear, thus insuring the point moving in front and striking the target. By this simple and ingenious mechanism the superiority of the bow over stone-slinging machines was speedily demonstrated.

The Parthians also were famous archers, and probably owed to their bows their independence from the Roman yoke.

You will remember how helpless the Roman legions were, even though commanded by so able a general as the Emperor Julian, when pursued and harassed by the mounted archers of Parthia.

The *crossbow* was a more formidable arm than the bow even, since more powerful bows could be used, and the accuracy of the fire, for the average man, was much superior. It was introduced into England from the East by Richard Cœur de Lion at the time of the Crusades, but it was not adopted by the French till a somewhat later period.

The **Crossbow** consisted of a bow mounted crosswise upon a stock shaped something like a gun-stock, with the butt arranged to fit against the shoulder, and permit accurate aim to be taken by the eye. Along this stalk was a channel in which was laid the arrow. Towards the rear, and about in the position of the hammer of a modern gun-lock, was a small wheel, in a notch on the rim of which was the bow-string when drawn back for a shot. To this wheel was attached a trigger; and when the trigger was drawn, the wheel revolved, releasing the string which chased the arrow before it along the channel.

When the bow was very strong, there was attached a reel and crank for hauling back the bow-string to its place.

The **Arquebuse** (from *arqui*, or *arc*, and *buse*, a nozzle or tube) was a crossbow in which the open channel was replaced by a tube or barrel, to contain the projectile, which was generally a lead ball. This barrel was slit on either side to allow the bow-string to traverse back and forth.

The sling, bow, and crossbow had the disadvantage of spreading the troops out so that their formation was not suitable for receiving charges of cavalry, and, besides, their range was not very considerable.

Hence we are not surprised that a low value was set upon them in the ancient armies compared with the *hand*-arms, like swords and pikes, which permitted a close order and the shock of heavy lines or columns.

When firearms were first introduced, although very much superior to the ancient *projective arms*, they were not adapted to the kind of formation then in vogue. Men armed with them could not act in the interior of solid squares which were used to resist cavalry; but after the fire of artillery had abolished the practice of deep formations, and when the musket had become both a *hand-arm* and a *projective* arm, the infantry found their principal force was in their fire.

The use of *defensive armor* was general in ancient warfare. The infantry of the line wore helmets, cuirasses, steeled half-boots and bucklers; and the heavy

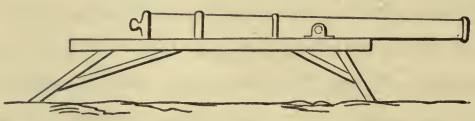
cavalry were cuirassed by bands of leather covered with sheet-brass. Coats of mail were worn in the time of Charlemagne, but continuous armor was not yet introduced. In France Louis VII. first adopted that kind of armor. It was improved and rendered heavier from time to time, so that at last a knight could only be killed by the battle-ax or morteau, which could crash through his habiliments of steel. But the fire of artillery, which soon after came into general use, changed this fashion.

Firearms. — When firearms were first introduced as a military weapon, they were not what we now call portable firearms, that is, such as are easily handled by one man, but were much heavier.

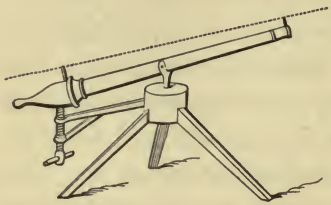
The *culverin,* the *hand-cannon,* the *baston,* and *bombard* were the various names of certain arms which were much the same, consisting essentially of an iron or brass tube which was mounted on a trestle when it was to be fired. They were loaded with gunpowder and a ball of lead, and fired off by means of a burning match. They required two men for their service, as they weighed from 25 to 70 pounds. Although such machines would nowadays be regarded as ridiculously clumsy and inefficient, they had a very decided effect, since there was no cuirass that could withstand their projectiles. Accordingly they multiplied rapidly; introduced first about 1350, by the year 1380 they were in general use.*

* It is said by some that the English had five cannon placed on a hill near the village of Crecy in 1340, during the famous battle there under Edward III.

Breech-loading weapons also were invented and tried about this era; some of these cannons having a movable breech or chest to contain the charge, which could be taken out and replaced, being fastened in position by an iron key or wedge; but as these arrangements were not sufficiently secure, and gave rise to numerous accidents, they were soon abandoned.



As the culverins were heavy and awkward to handle and point, they were soon replaced by a smaller gun resting on trunnions, which permitted them to revolve on a horizontal axis, and the inclination was given by an elevating screw placed under the breech. The whole was supported by a tripod. By this means the gun could be turned in any direction, and the necessary elevation or depression given to it. The breech terminated in a handle, which was held in the left hand while the match was applied by the right. These guns were denominated arquebuses, without any very good reason that we can see.



Soon after this was invented a lighter kind of arquebuse, fitted on to a stock that could be raised to the shoulder. The vent was pierced in the side of the breech, and there

was a pan provided near to and under it, to hold the priming powder. The marksman held up this arquebuse with his left hand, at the same time pressing it against the shoulder, and with the right hand applied the lighted match to the powder in the pan. Still this arm was too heavy to be used without a *rest*, which was accordingly provided in the shape of a fork stuck in the ground.

The improvement of firearms rapidly brought on their adoption. They were used by the Burgundians to defend Arras against Charles VI. in 1414, and in 1449 twenty thousand men armed with arquebuses marched from Milan to raise the siege of Mariquan.

At a time somewhat subsequent, the people of Brabrant used 300 small bombards in the siege of Bruges.

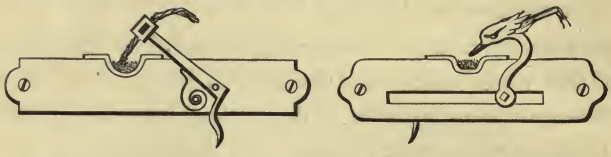
Firearms were slow in making their way among the French, owing to the attachment of that people to the institutions of chivalry; but they began to come into use under Charles VII. and Louis XI. At that epoch they were quite common in Switzerland, Flanders, and Italy.

Ten thousand hand-cannons were employed by the Swiss in the battle of Morat; and in the expedition of Charles VIII., one tenth of the infantry were armed with arquebuses, and in the time of Francis I. they had become common in France.*

Although the arquebuse had been manufactured so light that it could be fired without the use of a rest, it was

* They were introduced into the English army in 1471, when Edward IV. landed at Ravenspur, having 300 Flemings in his train, who were armed with portable firearms.

impossible to attain much accuracy in the fire, on account of sighting while touching off with the match. This inconvenience was remedied by the two following inventions. The first was made in 1380, and consisted of a kind of sweep, or vertical piece revolving on a horizontal axis, the lower end occupying the position of a trigger, and being pressed by the finger in the same manner. The upper end was composed of two jaws enclosing a piece of burning slow-match; when the finger was pressed on the trigger, this upper end approached the priming-pan and inserted the end of the match into the powder.



The second kind of mechanism, called the wheel-lock, was perfected at Nuremberg in 1517. It consisted of a small wheel made of steel, having its circumference cut into little channels and ribs, — like the edge of a milled dollar. This wheel was placed in the priming-pan, to the bottom of which it reached in the midst of the powder. The wheel was connected on the interior with a small chain, which chain was attached to a spring, after the manner of the machinery of a watch. Behind the pan was the *dog* or *cock*, holding between its jaws a composition of iron and antimony, which was called pyrites. A spring pressed the dog down, bringing the composition in contact with the periphery of the wheel.

To put this lock into action a crank was fitted on the end of the shaft of the wheel, and by turning the crank the chain was wound up around the axle and the spring drawn taut. When wound up, a small pin was slipped in to hold the wheel in place, and then the crank was removed. The gun was now ready to fire, or cocked, as we would say nowadays. To fire it off the cover of the pan was turned on its hinges, disengaging the pin; immediately the spring set the wheel to turning, and its rough edge whirling in contact with the composition created sparks of fire, which exploded the priming.

Small arquebuses with this kind of lock were made about the year 1545 for the use of cavalry. They were short, and the stock terminated in a gripe for the hand, being intended to be fired with only one hand, the arm being extended. They were first fabricated at Pistoie, a town in Tuscany, and hence were named pistols.

The diminution of the caliber of the arms rendering their effect too slight, some arquebuses of a heavier caliber were made, the stock at the rear departing from the line of direction of the bore at a considerable angle. This was done to diminish the shock from the recoil; which was effected still further by placing the butt of the piece against the plastron of the cuirass, thus spreading the influence of the recoil over a greater surface. They were called petrinals, or poitrenials, from the French word for breast. They were, however, very awkward pieces, and were soon abandoned.

We may as well explain the word *caliber*, or *cotober*,

which we have just used. The caliber of an arm is determined by the weight of its projectile in aliquot parts of a pound; thus a gun is of the caliber of twenty when twenty of its balls weigh a pound.

The Spaniards, under the Emperor Charles V., used at the battle of Pavia the *mousquit*, or musket, which was a heavy arm of the caliber of eight, and required a fork for a rest. These pieces were soon after successfully reduced in caliber down to eighteen or twenty to the pound, and this caliber has reached down to our days.

Rifled arms, that is, pieces with spiral grooves cut on the interior of the bore, were known as early as the end of the fifteenth century.

The invention of firearms did not bring about the immediate disuse of the sling, the bow, and the crossbow. They were not finally abandoned as military weapons until about 1560, while the English, owing to their superiority as archers, clung to the bow until 1627.

Notwithstanding the advantages presented by the new arms, they possessed the same drawback as the old ones in preventing that kind of formation necessary for resistance to the onset of cavalry.

Such was the condition of firearms after three centuries of experiment and improvement, when the invention of the flint-lock brought about an entire revolution.

The matchlock required the soldier to keep on hand a supply of slow-match and to keep it burning, which betrayed ambuscades and night marches; besides it was almost impossible to use them in damp weather, and quite

out of the question in the rain. The wheel-lock, although somewhat better, was complicated, costly, and often missed fire.

The flint-lock was introduced, and speedily it went through a number of modifications, until it attained the form which all are familiar with, wherein the trigger, being pulled by the finger, gives play to the main-spring, the main-spring dashes forward, the cock having the flint in its jaws; the flint strikes against the steel face of the battery, peeling off little fragments of the metal, which by the friction and velocity of the flint develop heat sufficient to become red-hot, forming sparks. The shock throws back the battery, exposing the powder in the priming-pan, and the sparks, falling into the same, explode it. This superior arm required a considerable time to drive out the match-lock, which was so extremely simple, from that dread of complicated machinery which militates at the present time against the adoption of improved arms. The flint-lock was introduced into the English service in 1692, under William of Orange.

The musket was finally recognized as by far the best *projective* arm ever known amongst mankind, but it was not yet a *hand*-arm. Accordingly the first and second ranks were armed with pikes to resist cavalry, and three or four ranks in rear of them were provided with muskets. The invention of the bayonet, which speedily followed, converted the musket into a *hand*-arm as well as a projective arm, and it could now fulfill the office of the pike, which it soon superseded, and reduced the formation of

infantry to four ranks at first and then to three ranks. At the present time, in some services, as that of the United States, for instance, there are but two ranks.

The **Bayonet** takes its name from Bayonne, where it was first fabricated in the year 1640. At first bayonets were small pikes, that is, they had a steel pike-head set upon a short wooden stock, which was inserted into the muzzle of the musket. They had, of course, to be removed before firing. Thirty years after, a bayonet with an elbow, and a hollow socket to fit over the muzzle, was invented; and the musket in this perfected state solved the important problem how to properly form the infantry of a modern army.

Gustavus Adolphus is accredited by some authors with the invention of *the cartridge*. This invention increased wonderfully the rapidity of the fire, though at first the priming-horn was used with a finer kind of powder for priming, and it was only in 1744 that the cartridge was used both for loading and priming.

The next step was the invention of the *percussion-cap*, in the present century. This is an English invention,* and speedily drove the flint-lock out of use.

In the percussion-lock the hammer strikes on a small copper cap placed on a small hollow tube, or cone, which opens on to the charge in the bottom of the gun-barrel. It is much more certain than the flint; the explosion takes place more promptly, which increases the accuracy of the fire; and firing can take place even in heavy rains.

* By the Rev. Mr. Forsythe.

In the bottom of the cap is placed a small quantity of fulminating powder, composed of two parts of fulminate of mercury to one of saltpeter. This is protected from dampness by a coating of Japan varnish, or some other lacker. The ramrod, or rammer, was formerly of wood; one *iron* rammer being furnished to every ten men; but now all muskets are provided with steel rammers.

The percussion-musket, with its improved bayonet, would seem to have left but little to be wished for in the way of an infantry weapon; but, on the contrary, the number of proposed improvements has, since its introduction, been greater than ever before. Men of mechanical genius, both soldiers and those in civil life, and in all civilized countries, during the last twenty years, have turned their attention in this direction. The consequence has been an enormous number of projected and patented improvements, some of which enjoyed a brief celebrity and were then thrown aside, while others, of more enduring worth, remain and mark distinctly the different stages of progress.

The problem which those men have proposed to themselves had three branches: —

1. To increase the rapidity of fire;
2. To increase the range of the projectile;
3. To increase the accuracy of the fire. To strike the enemy more surely, to strike him farther off, and to strike him more frequently, was then the object in view.

We cannot undertake to notice, even in a cursory manner, all these improvements, for want of space and

time, — it would require volumes, — nor would the amount of benefit or interest be commensurate with the labor and patience requisite were we to go over them all. I shall therefore confine my attention to the more important.

The general tendency of experiment and improvement has been in the direction of the abandonment of the smooth-bore and the substitution of the rifle. We have already adverted to the knowledge of the theory of rifled arms in former times. The difficulty of loading and the slow rate of firing caused them to fall into disuse, or rather prevented their coming into general use.

Their superior accuracy, however, kept them in the hands of sportsmen, and they have been largely used by the people of the United States, even as a military weapon, as is shown by the history of our perpetual contests with the Indians upon our borders, and of our wars with Great Britain.

The victory of General Jackson at New Orleans over the veterans of Packingham, who had been seasoned by years of fighting under the leadership of so great a master as Wellington, against the French led by Napoleon's marshals, was mainly due to the deadly accuracy of the American rifles. The rifle is in an especial manner the weapon of America.

The Germans were the first in Europe to make much use of the rifle. Arms with grooves were used in Germany as early as the fifteenth century. These grooves, however, ran straight and parallel to the axis of the bore. No notable improvement was observed, but they served

at least the good purpose of demonstrating that the ball would obey the grooves and move in the direction of this axis. Subsequently an immense improvement was found to be produced by making the grooves helices, or giving them a *twist*. The ball was then found to move with two motions: one of direct translation due to the impulse of the gases caused by the burning of the powder; and another of rotation about an axis parallel to that of the bore. This latter motion of rotation was found to be increased by increasing the twist of the rifles or grooves. But there is a practical limit to this, because of the increased friction and retardation which results in the little ridges of lead which fill the grooves stripping off and the ball marching direct across the grooves and *lands* or spaces which separate them.

A variety of circumstances must be taken into account in establishing the inclination of the grooves; a sort of general indication is, that in a rifle-musket with a barrel about forty inches long the grooves should make about a half-turn in the bore.

Different Methods of forcing the Ball into the Grooves. — The first was to force a tight ball, either naked or covered with a greased patch, into the bore, and when at the bottom, by blows of a mallet or with the rammer, to compress the lead, cause it to spread out and fill the grooves. This operation deformed the ball, injuring the accuracy of its flight, and required besides much time.

Another method was to load at the breech, the chamber into which the ball was inserted being somewhat

larger than the bore; the gases forced the ball forward, completely filling the grooves. This was no doubt the best method; but the complicated and imperfect mechanism of breech-loaders heretofore has kept them in disfavor, and it is only at the present day that a satisfactory solution has been found to the problem to make a good breech-loading rifle.

A third method was to cast the balls with ridges prepared to fit the grooves, and load at the muzzle.

As you will readily imagine, this did not entirely destroy the windage; besides, it did not give good practical results.

The fourth method consisted in simply pushing a very tight ball covered with a patch down to the position of the powder, but *without ramming*. This was the American custom. The hold taken on the ball by the grooves was but slight, and only a portion of the benefits of rifling were obtained.

As early as 1828 Captain Delvigne proposed a breech-pin hollowed out to sufficient depth to contain the powder of the charge, and leave a small amount of space to spare.

This chamber was of somewhat smaller diameter than the bore of the piece, so that the bottom of the bore, by its connection with the mouth of the chamber, formed a projectory rim or shoulder upon which the ball rested and by which it was prevented from entering the chamber and being pressed down on the powder. The powder was thus secured from being crushed and injured, and

besides, two or three taps of the rammer caused the ball to expand into the grooves equally on all sides. This was a very great improvement; but the ball was much deformed by the blows of the rammer, and the lower part was, in point of fact, driven into the chamber to such an extent as to diminish seriously the amount of space which there should be between the powder and the projectile, and in some cases even to press upon the powder.

Pontchara System. — To remove the defects just spoken of, Colonel Pontchara proposed to place on the bottom of the ball a small wooden *sabot*, which was a short cylinder hollowed out on top to make a bed for the ball, and having a greased patch on the lower end which extended a part of the way up the sides. The sabot was to prevent the lower portion of the ball being hammered into the chamber, and the greased patch was to clean the gun of dirt and residuum. Meanwhile a great variety of grooves or rifles, differing as to number, inclination, depth, and shape of cross-section, was tried, to find out by experiment the best.

The Système à tige was next introduced by two French officers, MM. Thouvenin and Minie.

Instead of the chamber hollowed out of the breech-pin, a *tige*, or stem, was screwed into the breech-pin and extended a short distance in the direction of the axis of the bore. Around this stem, or tige, lay the powder of the charge, and on its top rested the leaden ball which expanded into the grooves as before under the blows of

the rammer. By this time the rammer-head had been hollowed out so as not to flatten the upper surface of the ball.

Minie also tried a ball of a new shape, the *cylindro-conical* ball, being a cylinder terminated towards the front by a cone. Near the base of the cylinder was cut a groove. This groove was found to play a very important part, but the origin of it was somewhat singular. It was intended at first to be merely a little reservoir for grease, to replace the greased patch of the Delvigne system. A woolen yarn was saturated with grease and tied into this groove, whence, as the ball moved along the bore, it dispensed its grease to the sides of its cylindrical surface. When, from any cause, the thread was left off and the groove remained open, it was discovered that the accuracy of the ball's course was very much increased.

We will refer to the philosophical cause of this effect again.

The stem was 1.417 inches long; its top was flat; it was a cylinder of 0.34-inch diameter; the rifle had 4 grooves, which made one turn in 4.664 feet; the caliber was 0.689-inch; and the ball, of which the diameter was 0.676-inch, weighed 1.65 ounces.

The charge of powder was 64.8 grains; and the gun, without its bayonet, weighed 10.15 pounds. The elevating sight, or hausse, was graduated up to 1,421 yards.

Experiments upon the grooves demonstrated that there should be at least *two*, because one caused the ball to leave

the gun in a false direction, but that the number should not exceed *four*.

It was also ascertained that there existed a certain relation between the twist of the grooves and the charge of powder. When the grooves were much inclined, a heavy charge drove the ball across the grooves, deforming its shape and losing the rotary motion; on the other hand, when the grooves had too little inclination, there was not sufficient rotation.

It was also discovered by the experimenter, that if the grooves had a twist to the right from the left, the ball deviated to the right; and if the turn was from right to left, the ball went to the left of the point aimed at. To this deviation the name *dérivation*, or drift, was given.

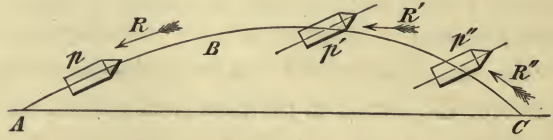
They finally settled upon a twist of one turn in 6 feet and from left to right, the drift to the right from this inclination being counteracted, as they supposed, by the natural inclination of the soldier to aim too much to the left, especially at long ranges.

A multitude of experiments was made upon the shape of the ball; combinations of the cylinder and cone were made in every possible way.

One remarkable result led to the suspicion that much of the accuracy was due to the groove, or cannelure, around the base of the ball. Study and experiment developed the theory of Captain Tamissier of the French artillery as follows: In order that a cylindro-conic ball may have the best possible effect, it is necessary that the point should keep in front, and that its axis of rotation

should follow the inflection of the trajectory. Should the axis of the ball maintain constantly its first direction, the resistance of the air would tend to make it turn about an axis perpendicular to the trajectory, and passing through its center of gravity.

For example, let A B C be the trajectory described by the center of gravity of the ball, p p' p'' three positions



of the ball on the curve with its axis parallel to its first position, and R R' R'' the direction of the resistance of the air, which acts always in the direction opposite to the ball's motion. It is seen from the figure that at the position p the resistance R has only the effect to retard the motion, but that in the positions p p'' the forces R' R'' acting upon a greater surface than R to retard the motion, tend at the same time to force the axis of the ball more and more from the trajectory and to make it turn in a direction opposite to that of its flight.

Now suppose there was a groove around the base of the ball; the moment its point was raised off the trajectory the groove on the under side of the cylindrical part would be opened out and exposed to the action of the current of the air, which would haul the point down again to the trajectory. And if the point were to deviate to right or left, or in any direction whatever, it is easily seen

that the same action would take place, and bring the point back to the trajectory.

Tamissier believed that if the number of grooves should be increased, this effect would be enhanced, as more surface would be presented to the action of the air. Accordingly he had such balls made, and experiment confirmed his theory, and established *three* as the most suitable number of grooves.

Balle à culot. — In the tige rifle, as was seen above, the ball was compelled to expand into the grooves by blows of the rammer. But this effect was produced in very unequal degrees by different men; some scarcely expanding the ball at all, while others hammered and mashed the ball out of all shape. It was sought to remedy this defect by expanding the ball by the action of the powder alone, and without the action of the soldier in the matter.

Minie-Ball. — Captain Minie invented a ball with a hollow in its base of the shape of a frustum of a cone, into which a little *culot*, or wedge, which was of iron and of the same kind of shape, was forced by the action of the powder; expanding the sides of the ball so as to fill the grooves with the lead. The general shape was cylindro-conic. This was the celebrated Minie-ball, of which all have heard so much. The Minie rifle is any rifle firing the Minie-ball.

At the termination of experiments made with the Minie ball, and which demonstrated its practical success in the year 1849, Captain Faucompré, of the French artillery, presented a hollow ball which he claimed would be ex-

panded by the action of the gas *without* the aid of the *wedge*. Experiments showed that the expansion of this ball was very good, though inferior to that of the wedge-ball.

And trials led to the important discovery that Minie's new ball did almost, if not quite, as well without the wedge as with it. When it is fired without the wedge, the gas enters the cavity and stretches it outward in all directions, instantaneously and completely cutting off the windage and filling the grooves.

A multitude of experiments have been made on sundry modifications of balls, and many peculiar advantages have been claimed for this, that, and the other ball; but the limits of a paper like this will not permit me to enter upon an account of them.

And these experiments were not confined to the ball, but many modifications and projected improvements have been made in the arm itself. The singularity of the *Lancaster rifle* merits a passing notice. This is an English invention, and its peculiarity is in the construction of the bore. It was 39 inches long, *and had no grooves,* but was smoothly and elliptically bored out. The elliptical bore had an increasing twist and a diminished cross-section as it approached the muzzle; the smaller axis — which is to be regarded as the caliber — being 0.543-inch at the breech and 0.540-inch at the muzzle, while the greater axis — which takes the place of the grooves — was 0.557-inch at the breech and 0.543-inch at the muzzle.

The twist was half a turn in the length of the bore. The ball was a cylinder terminated at the front by a hemisphere. There was a conical cavity in the base of the ball filled by a conical plug, which expanded it on the wedge principle. There were three grooves on the exterior of the cylinder of this ball.

The Lancaster rifle gave good results as to range and accuracy, but it was difficult to load, and liable to accidents from jamming of the ball, if any impediment occurred in its passage out of the bore.

Breech-Loaders. — The great advantages of loading a gun to the breech, for all purposes, and more particularly for men on horseback, are so palpable, that numerous endeavors to construct a good breech-loading arrangement have been made from time to time.

Heretofore these mechanisms were so complicated that they not only made the arm very expensive, but they easily got out of order, and were condemned as practical failures.

Various kinds of revolvers were tried likewise. In these a number of chambers already loaded revolved into conjunction with a common barrel, and were discharged through the same; or else a number of barrels previously loaded were revolved into a position where they were successively discharged by a common hammer. The best of these were Colt's, an American invention, and that of Dean and Adams, an English modification of the principle of Colt. These are so familiar that we need not linger upon them.

Repeating Rifles. — These are a still greater advance and improvement. They use a metallic cartridge, con-

sisting of a copper tube closed at one end, at the bottom of which is placed the fulminate; on top of this comes the powder of the charge, and the ball, of the approved, elongated pattern, closes the mouth of the tube, thus presenting the priming, charge, and projectile in one neat, compact and convenient cartridge, admirably adapted to breech-loading.

Some of the most recent and best of the breech-loaders are the *Remington, Sharpe, Peabody, Ballard,* and the *Prussian needle-gun,* and *Chassepot* of the French.

The needle-gun, however, does not use the metallic cartridge above described, and is fired by a slender steel shaft, or needle, driven forward by a helical spring penetrating from the bore of the cartridge to its front, where it passes through the fulminate, igniting it and exploding the charge. This presents the unique advantage of causing the powder of the charge to burn progressively from front to rear, thus making use of all the powder.

When the fire is communicated at the bottom of the cartridge, some of its grains are blown out of the bore, like small projectiles, and lost.

This gun, although made so famous by recent events, is much inferior to some of the rifles mentioned above, because the latter are not so complicated, and can be used more expeditiously.

The next progressive step beyond these was a class of breech-loaders, which were not single-loading breech-loaders, but had magazines where were deposited several cartridges, which were successively introduced into the bore

by the machinery itself. The *Spencer* is such a rifle, having a magazine in the butt of the stock extending from the lock down to the butt-plate. It contains *seven* cartridges, and the arm was invented in 1860.

Next came, in 1862, the "Henry" rifle, which has a magazine extending along the under side of the whole length of the barrel, and containing fifteen cartridges.

This gun is operated by two very simple motions, and can be fired thirty times in a minute, without unusual haste. It can be fired twice as fast as the Spencer rifle, and six times as fast as the Prussian needle-gun.

A modification and great improvement on the Henry rifle is the *Winchester* rifle, another *American arm.*

The magazine is entirely closed, excluding dampness and dirt; and while the machinery for loading and firing is the same as that of the Henry gun, there is a much improved mechanism for extracting the cylinder which contained the cartridge before firing, and it presents the double advantage of the magazine and an arrangement which makes it a single-loading breech-loader. So that it may be used as a single-loading breech-loader as long as may be desirable without ever using one of the shots in the magazine, and giving more rapid shots than the needle-gun does, and then, at the last moment, there is a reserve of fifteen shots, which could be fired in less than half a minute. And this remarkable weapon, presenting such unprecedented advantages, has a simple machinery not liable to be easily deranged.

CHAPTER X.

MITRAILLEUSE AND UNITED STATES ORDNANCE.

THE mitrailleuse is a revolver or revolving gun, mounted upon a cannon carriage like a field-piece. There are several different patterns, differing more or less in their details. The first was invented by Dr. Gatling, an American. It was patented in 1862. In general, this "machine-gun" consists of a number of barrels, — from six to thirty-seven, — assembled about an axis, to which they are parallel. They are revolved by a crank which is turned by hand, the barrels being fed with cartridges by a hopper fastened on top of the machine. The locks, which consist of three pieces, and a spiral spring, are concealed within a case of metal, near the base of the breech.

In the Gatling gun there is an arrangement by which it has a horizontal sweep over an arc of 12°, which permits a distribution of fire over an enemy's front of greater or less extent, according to his distance. The following is copied from the "Army and Navy Journal" of August 20, 1870: "The mechanical simplicity of the Gatling gun is its distinguishing merit. The report of Lieutenant-Commander Skerrett to Rear-Admiral Dahlgren, dated May 20, 1863, we reproduce as a fair description of the battery then

submitted for approval: The gun consists of six rifle barrels of $\frac{58}{100}$-inch caliber; each barrel is firmly connected to a breech-piece by a screw of one inch in length.

The breech-piece is composed of one solid piece, which is made secure to a shaft one and three fourths inches in diameter. The barrels are inserted in the breech-piece around the shaft on a parallel line with the axis of said shaft, and held in the proper position by a muzzle-piece bored by the same gage as the holes for the breech-piece for the reception of the barrels. The breech-piece is also bored in the rear end for the reception of the locks, on a parallel line with the barrels, each barrel having its own independent lock revolving simultaneously, so that in case one lock or barrel becomes disabled, those remaining can be used effectively.

Between the locks and the barrels is a receptacle for the charges on a parallel line with the locks and barrels. As the entire gun revolves, the charges find their way through a hopper, fed from cases, containing any given number, instantaneously. The breech-piece contains the locks, and is protected by a heavy casing of gun-metal, made fast to a upright iron frame, resting on trunnions one and a half inches in diameter. It is screwed to the frame by four bolts. Inside this casing is attached an inclined ring which the hammers of the lock ride until coming to the point of the line of fire, when the discharge takes place. The locks are composed of three pieces and one spiral spring, and are entirely protected from dust or any injury. The gun is mounted as other field-pieces, with limber attached.

The Journal further states that there are now manufactured of the Gatling gun five sizes, — "a ten-barrel gun of $\frac{42}{100}$-inch caliber, of $\frac{50}{100}$, of $\frac{65}{100}$, of $\frac{75}{100}$, and a six or ten barrel gun of one-inch caliber. The first two are capable of over 400, and the larger sizes of 200 shots per minute. The largest size discharges a solid lead ball of $\frac{1}{2}$ pound weight (a shower of 100 pounds per minute), or a canister cartridge containing 16 balls, and has an effective range of $1\frac{1}{2}$ miles; the second size, $4\frac{1}{2}$-ounce balls; the third, 1,490 grains; the fourth, 450; the fifth, 370. With the three smaller calibers the weight of metal is canister.

A recent trial of trajectory showed for

	Deg.	Min.
300 yards an elevation of . . .	0	54
500 " " " " . . .	1	20
800 " " " " . . .	1	59
900 " " " " . . .	2	5
1,000 " " " " . . .	2	26

ORDNANCE OF THE UNITED STATES SERVICE.

The following is a list of the different kinds and calibers of the ordnance now in use by the army of the United States, for which the author is indebted to Colonel Julian M'Allister, United States Ordnance Corps: —

2.90-inch 10-pdr. Parrott gun, iron, banded; projectiles $10\frac{1}{2}$ and $9\frac{3}{4}$ lb.
3 " 3-inch ordnance rifled gun.
3.67 " 6-pdr. smooth-bore, bronze.
3.67 " 20-pdr. Parrott gun, iron, banded; projectiles $19\frac{1}{2}$ or $18\frac{3}{4}$ lb.
4.20 " 30-pdr. Parrott gun, iron, banded; projectiles 29 lb.
4.50 " siege gun, iron; projectiles 36 lb.

4.62-inch 12-pdr. smooth-bore, iron, bronze.
4.62 " 12-pdr. smooth-bore, iron; siege and garrison.
5.30 " 18-pdr. smooth-bore, iron; siege and garrison.
5.82 " 24-pdr. smooth-bore, iron; siege and garrison.
6.40 " 100-pdr. Parrott gun, iron, banded; projectiles 101, 99½, and 80 lb.
6.40 " 32-pdr. smooth-bore, iron; sea-coast.
7 " 42-pdr. smooth-bore, iron; sea-coast.
7 " 42-pdr. smooth-bore, iron; banded.
8 " 200-pdr. Parrott gun, iron, banded; projectiles 150 lb.
VIII " Rodman, smooth-bore, iron.
10 " 300-pdr. Parrott gun, iron; banded.
X " Rodman, smooth-bore, iron.
XII " Rodman, rifled-gun, iron.
XIII " Rodman, smooth-bore gun, iron.
XV " Rodman, smooth-bore gun, iron; projectiles 328 lb.
XX " Rodman, smooth-bore gun, iron; projectiles 1,000 lb.; charge, 250 lb of powder.

SHELL GUNS.

Bronze, field; 4.62-inch, 5.82-inch, 6.4-inch.
Iron, siege; 5.82-inch and 8-inch.
Iron, sea-coast; 8-inch and 10-inch.
Columbiads; 8-inch and 10-inch.

MORTARS.

5.82-inch Cochorn; bronze.
8 " light, siege; iron.
8 " heavy, sea-coast; iron.
10 " light, siege; iron.
10 " heavy, sea-coast; iron.
13 " heavy, sea-coast; iron.

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